DOCUMENT RESUME

ED 086 239 IR 000 093

AUTHOR	Scanlon, Robert G.; Weinberger, JoAnn
TITLE	Improving Productivity of School Systems Through Educational Technology. Final Report of Symposium.
INSTITUTION	Research for Better Schools, Inc., Philadelphia, Pa.
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C. Educational Technology.
PUB DATE	Aug 73
CONTRACT	OEC-0-73-6811
NOTE	330p.; See Also IR 000 095
EDRS PRICE	MF-$0.65 HC-$13.16
DESCRIPTORS	Conference Reports; Educational Economics; *Educational Improvement; *Educational Technology; Elementary Grades; Human Engineering; *Instructional Improvement; *Instructional Technology; Management Systems; Models; Political Issues; *Productivity; Secondary Grades; Social Factors; Symposia; Telecommunication

ABSTRACT

Full texts of ten commissioned papers are presented, along with discussants' remarks and an analytical review by the editors. The symposium was held to explore the potentials and implications of using advanced communications and technological systems to improve educational productivity. Major foci included: 1) the use of management models to increase educational productivity; 2) the adequacy of planning cost models for predicting the resource requirements of technological alternatives; 3) the problem of relating input strategies to output measurements; 4) the utility of case histories for illustrating the effectiveness of technology-based instructional systems; and 5) the examination of the human, political and social factors involved with the development of technological systems in education. (Author/PB)

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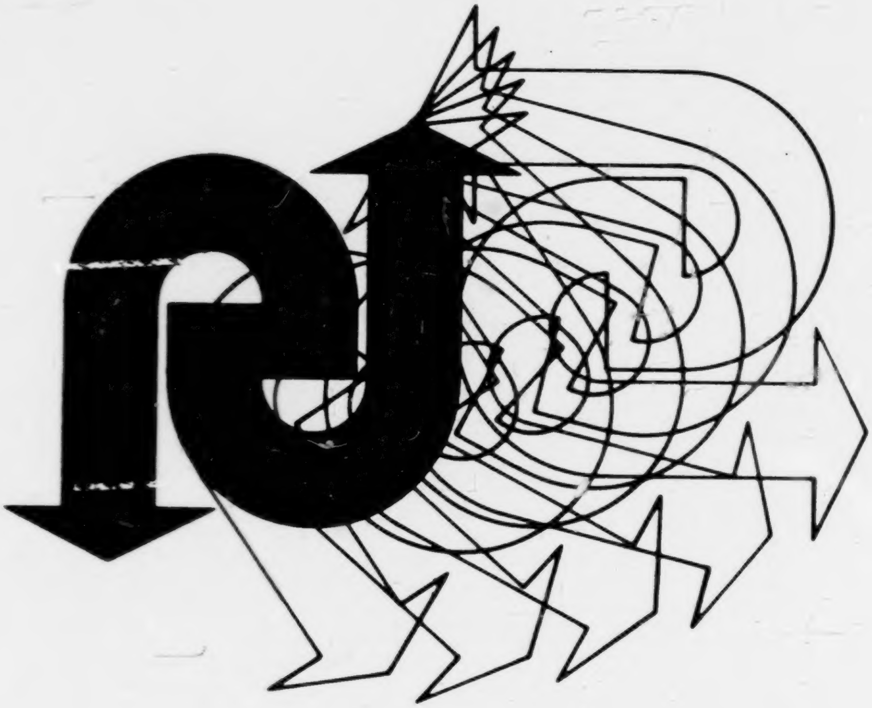

IMPROVING PRODUCTIVITY OF SCHOOL SYSTEMS THROUGH EDUCATIONAL TECHNOLOGY

FINAL REPORT OF SYMPOSIUM

August 1973

IR 000 093

RESEARCH FOR BETTER SCHOOLS, INC.
1700 MARKET STREET
PHILADELPHIA, PENNSYLVANIA 19103
(215) 561-4100

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The work upon which this publication is based was performed persuant to Contract OEC-0-73-6811 with the National Institute of Education, Department of Health, Education, and Welfare.

ED 086239

IMPROVING PRODUCTIVITY

OF

SCHOOL SYSTEMS THROUGH EDUCATIONAL TECHNOLOGY

Final Report of Symposium

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ACKNOWLEDGEMENTS

Research for Better Schools, Inc., an educational laboratory, has, as its primary mission, the restructuring of education with emphasis on individualizing and humanizing the learning process. Products are developed that will not only optimize opportunities for intellectual growth, but also promote self-reliance, responsibility, and responsiveness to changing social and technological environments. Thus, the need to more clearly understand the potentials and implications of adopting alternative instructional delivery systems that make wider use of technology-based approaches and products was recognized by the staff.

We wish to acknowledge James W. Becker, Executive Director of the National Foundation for the Improvement of Education, for moderating the symposium. To the participants who delivered commissioned papers and discussants who reacted, we express our appreciation for meeting the tight timelines required for preparing their papers and remarks.

We further wish to acknowledge the staff and consultants of Research for Better Schools for their many labors in bringing this volume to its present form. For their help we wish to acknowledge: Jeanne Bowers for formatting, typesetting and compilation of press-ready copy; Mary Lou Davis for coordinating the myriad tasks; Ernestine Talbert for aiding bibliography preparation; Theresa Haskins for after-hours efforts in completing the final manuscript; and Helene Isaacson, Barbara Cicalese, and other proofreaders for their needed assistance.

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INTRODUCTION

INTRODUCTION

Utilizing the tools of technology in school systems is a practice as old as the tools themselves. Back in the 1930's, films, slides and phonograph records made up the bulk of audio-visual aids. Research and development activities during World War II brought about many refinements in these tools and by the late 1940's television and the tape-recorder had found their way into school classrooms and auditoriums. Then, during the 1950's, technology-based instructional systems such as the language laboratory were introduced. However, the innovations of the 1960's and early 1970's far outstripped all that had transpired before. A rapidly maturing computer entered the scene, providing a staggering application potential for instructional purposes in addition to its many data processing functions. By the summer of 1973, cable television and communications satellites, along with audio/video tape cassettes, completed the tool chest for educational technology.

A craftsman with such a formidable array of tools could be expected to produce highly professional, finely finished products. If so, what are these products? How were they developed, tested and produced? What was the cost breakdown and who paid the bill? How did the consumers respond? Where does the product stand now? What new products can we expect in the near future?

These were some of the questions the Office of Education's National Center for Educational Technology (NCET) hoped to have answered when it initiated this symposium, "Improving Productivity of School Systems through Educational Technology" which was designed and conducted by Research for Better Schools, Inc. The project was subsequently transferred to the National Institute of Education's Technology and Productivity Task Force. Specifically, the symposium, held August 20-22, 1973, was designed to explore, in depth, the potentials and implications of using new and advanced communications and technology-based systems for improving educational productivity. Commissioned papers, discussions and this final report were to focus on the issues relating to the instruction and maintenance of alternative cost-effective methods of providing instruction. These methods were to be explored in the context of the total spectrum of human systems involved in the educational process.

The papers published herein reveal, possibly for the first time under one cover, the sum of the products evolving through educational technology as of this moment; economic, management, and evaluation factors; human, political and social considerations; and, finally, a look at the future of education in our society and the future of technology in our educational system.

Discussants remarks are equally revealing, both in substance and in tone. The wide-spread utilization of technology-based instructional systems has its opponents, proponents, and sympathetic well-wishers. Their views, representative of the real world of administrators, teachers, state department officials, business community members and the teachers' union, are worth careful study and thoughtful consideration.

For the three day symposium, the basic objectives and subsidiary questions to be answered were:

1. To determine management models needed for supporting educational productivity demonstrations; i.e., how to increase educational production through management models.

    - What would a model pattern of technological assistance look like?
    - What is involved in developing an operating prototype of a "model" pattern?
    - What are the institutional requirements?
    - What are the logistic requirements in terms of physical space, equipment, and personnel?
    - What personnel roles need to be identified?
    - What is the effect of the introduction of technology-based instruction on existing educational systems?
    - Which personnel roles need to be restructured and how is this to be accomplished?
    - What cost factors influence effective utilization of technology-based instructional management systems?

2. To evaluate the adequacy of planning cost models for simulating and predicting the total resource requirements for installing and maintaining technology-based alternative approaches.

    - What models should be considered in simulating or predicting resource requirements?
    - What are the costs of introducing and maintaining the technology in different models including:

        - retraining teachers and continuous in-service training
        - administrative retraining and continuous in-service education
        - space allocation remodeling and restructuring where necessary
        - installation of equipment - initial and maintenance
        - resource allocation of personnel

    - system operation and maintenance during and after takeover
    - investigation of overt and covert costs?

- What are the comparative costs versus effectiveness between different technological models and conventional instructional approaches?

- Where might convergence occur between cost model theories and current technological applications?

3. To examine the problems of relating input strategies to measurements of output.

    - What would a model pattern of a formative evaluation include?
        - evaluation of objectives
        - study of relationship of objectives and plan
        - study of relationship of operation and plan
        - study of relationship of operation and assessed results

    - What would a model pattern of a summative evaluation include?
        - study of relationship between instruction through technology and the effectiveness of learning for pupils with different characteristics and learning styles
        - study of relationship of immediate results to more ultimate goals
        - study of effectiveness of different technology models compared with conventional instructional approaches

4. To illustrate the availability of alternative technology-based instructional systems which show potential for improving educational productivity (case histories).

    - In what areas have prototypes been developed using technology-based instructional modes (e.g., diagnosis, testing, instruction, problem-solving, drill and practice, management, etc.)?

    - Where has technology been successfully applied and what conditions have contributed to its success?

    - Based on intensive examination of past applications, what are proposed new approaches to the application of technology to instruction and/or testing which have apparent potential for success?

- What has been the involvement of members of the community, teachers and administrators in the design of the technological response? In its use?

- What training have administrators, teachers, learners and technical operators received? With what effect?

- What factors have operated to inhibit or prevent widespread adoption and how can these pitfalls be avoided in future models?

- If the technological advance required major changes, what is the likelihood of their being accepted by teachers? administrators? members of the community?

5. To examine the human, political and social factors affecting, and to be effected by, alternative technology-based instructional systems.

    - What should be the teacher's role in the technology-based instructional system? What alternative roles may develop for teachers? for professionals?

    - What methods are used for training teachers and paraprofessionals?

    - How can teacher training institutions be involved?

    - How can the involvement of administrators be secured?

    - How can community acceptance be secured?

    - What interpersonal and instructional strategies are needed to make the application of technology to instruction viable in the school setting?

    - What are the funding parameters (e.g., sources, limits, extent) to be considered?

    - What is the nature of the priorities and commitments of the funding agencies?

    - What must be demonstrated to develop commitment of education and neighborhood communities in the uses of technology in instruction?

6. To recommend experiments and demonstrations to be conducted.

    - Based on the consensus of experiments convened, what experiments and/or demonstrations should be performed? What variables should be controlled?

    - What are futuristic possibilities to be explored?

For working purposes, educational technology was defined as follows:

> Educational technology is concerned with the facilitation of human learning through the systematic identification, development, organization, and utilization of a full range of learning resources and through the management of these processes. Learning resources include the people, materials, settings, tools and equipment and activities that are specifically **designed** for instruction and that exist are utilized for **instruction.** It includes, but is not limited to, the development of instructional systems, the identification of existing resources, the delivery of resources to learners, and the management of these processes and the people who perform them. Thus, through the use of educational technology, alternative institutional patterns can be provided for the facilitation of learning.

The complete papers of the ten major contributors followed by discussants' reactions provide the basis for Part II of this report. An analysis of these inputs coupled with the discussion provide the basis for Part III, An Analysis of the Issues, Problems, Strategies and Recommendations. Appended is an overview of the symposium itself including the list of attendees and session schedule.

CASE HISTORIES

USE OF THE COMPUTER IN INSTRUCTION

A Case Study

by

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INTRODUCTION

Various demands for change in education are a result of professional as well as popular concern for improving the quality of education, in both its form and content. Taxpayer resistance, demand for additional educational service for a broader spectrum of population and lower school budgets have created problems for education in general. Educators are looking into new instructional methods, varied curricula and technological developments to help alleviate some of these problems. The computer is a technological development that has application in learning.

Early uses of the computer in education were at the university level and date from the mid-50's. Data processing, scheduling and related uses were followed by application of the computer for solving problems at the secondary level as well as in higher education. Another application which led to experimentation with the use of the computer in education, especially instruction, was the experience with programmed instruction which had shown some success in meeting individual differences, but attempts at branching had led to cumbersome text formats. Using the computer was seen to not only accommodate students of various levels, but also to offer the additional advantages for individualizing instruction by controlling a variety of other media, such as films, filmstrips or language laboratories. For instructional purposes, the most recent and most significant developments have been the use of time-shared networks and mini-computers in schools. These developments open up many more possibilities that may lead to broad scale use.

Definition of Terms

Many terms are used to define the use of computers in instruction. Salisbury[1] states that twenty-one definitions can be found in the literature that describe "computer-assisted instruction." For this paper the following definitions will be used:

Computer-Assisted Instruction (CAI) - The computer used as a "tutor."

Drill and Practice: Material presented to the student to test knowledge of the student. The computer diagnosis, the aptitude level, presents a linear sequence of drill and practice exercises and then tests students for assignment to the next block of exercises.

Tutor: Student receives his instruction under the control of the terminal. The information displayed by the terminal depends not only on the choice that the student makes on that response, but also on the history of his response record and the latency of responses.

Simulation: The computer replicates a real or imaginary situation or environment. Application may involve the simulation of a chemistry experiment or a historic event.

Computer-Managed Instruction (CMI) - Computer keeps a record of student progress and "prescribes" individual work for each student. The role of the computer is to handle scoring, record keeping, matching of student performance to appropriate learning material, and scheduling.

Problem Solving: This use of the computer has as its major objectives the development of a precise, critical approach to analyzing a problem, developing proficiency in using the computer to seek solutions, understanding the capabilities and limitations of computers, and using the capabilities of the computer in various disciplines, such as mathematics, science, business and social sciences.

Some Applications in School Systems

Use of the computers in problem solving made its first impact in the secondary level, in the early 60's due to the work done by the National Council for Teachers of Mathematics (NCTM) and the School Mathematics Study Group (SMSG). Booklets and texts with problem- solving applications in mathematics led to the introduction of computers in the solution of mathematics problems. With the assistance of universities, schools were able to teach programming to high school students. This usage has spread to many secondary schools, some of which currently have plans underway to revise the mathematics curriculum to take advantage of the contributions the computer can make to the study of mathematics.

The use of a computer terminal to display curricular material has had its widest application with drill and practice material in mathematics due primarily to the work done by Suppes and his associates at the Stanford Institute for Mathematical Studies in the Social Sciences. In the first trial of the material with a group of 50 gifted first graders in 1964, the fastest child accomplished more than the slowest by 50 percent in the first month of the program. Suppes further indicated the growth was not substantially correlated with I.Q.[2] In another report he states that in a heterogeneous group of first graders in a tutorial reading program, the slowest child took 2,500 trials to reach criterion as against the fastest rate of 196 trials.[3]

Parkus[4] reported the results of one year's experience with the mathematics drill and practice program in the McCoomb, Mississippi Public Schools in 1967-1968. The students were in grades one through six and were administered the Stanford Achievement Test as a pretest in September, 1967, and as a posttest in May, 1968. The results indicated significant differences in computation and concepts as compared with a control group that received only regular instruction in the classroom.

In New York, where the drill and practice mathematics program was used in 16 elementary schools, a total of 4,573 students were evaluated.[5] Scores obtained from Form C of the Metropolitan Achievement Test were evaluated and showed higher gains from pretest and posttest in all grades two through six. However, the variables of school and teacher situation and hours of instruction were not controlled, making it not possible to evaluate to what extent the findings were accurate. Cincinnati, Ohio schools were also using the drill and practice programs in mathematics and reading. Ten terminals are in each of two elementary schools for use with students who have serious basic skill problems. Their findings indicate students who are further behind tend to profit the most. In Los Angeles, where some of this material was used, it was judged that students made four months gain for every month of practice. Chicago, after a two-year in-depth study of CAI, installed in 1972, 105 cathode ray tube terminals, located in seven elementary schools, which rank among the highest in poverty in the city of Chicago. The end goal is for a 480 terminal system. Each of the schools has a dedicated paraprofessional who is responsible for instructing students in the operation of the terminal. Three curricula are available in the drill and practice mode -- reading, mathematics and language aids. As in the other school systems mentioned above, Chicago personnel did not develop the curricula but purchased the software packages. The student spends an average of ten minutes time on each curriculum area. Teachers claim that a student receives five times as much practice using a CAI program as he does using a textbook. They also find they can give individual attention in specific areas as needed.

Few school projects are publishing their findings, especially in their work with tutorial instruction. The final report published by Montgomery County Public Schools[6] states favorable results obtained from the use of the tutorial modules developed by their teachers which are now in use in their secondary schools.

PHILADELPHIA SCHOOL DISTRICT - CASE STUDY

The programs developed and implemented by the Division of Instructional Systems are intended to reflect the following system-wide priorities.

1) Develop in each student a command of the basic skills and the ability to think clearly, communicate effectively and learn easily.

2) Increase the number of students receiving individualized instruction.

3) Increase the number of students actively engaged in Computer Courses.

4) Develop methods whereby each student is taught in ways which conform to his individual learning characteristics.

5) Provide each student with an awareness of career alternatives.

The goal of the Division is the active dissemination, maintenance and support of instructional programs designed by the staff of the Division for use in the School District. Essential conditions of implementation include both staff development and curriculum development as well as the capability to modify programs to meet the individual needs of participating schools.

Programs

1) **Computer Literacy:** The Computer Literacy program, developed by the Division of Instructional Systems, provides students in middle schools and junior high schools with an introduction to computer concepts. Some of the outcomes include an understanding of what information is, how it is processed, what a computer is, the

effects computers have and will have in our society, and an introduction to a programming language and to computer operations. Since its successful introduction through a pilot effort in the 1967-1968 school year, the program has been expanded each year to its present level to include all schools.

2) **Problem Solving:** This program, which is in every high school and technical school, has as its major objectives developing a precise, critical approach to analyzing a problem and developing proficiency in using the capabilities of the computer in various disciplines, such as mathematics, science, business education and social sciences.

The use of the computer in the above programs has some of the following objectives:

A. As an aid in establishing a clear, precise statement of a problem that is to be solved. Both the problem and the results must be clearly understood.

B. Introducing the student to an approach to problem solving which is based on logical sequential thinking.

C. Broadening the student's horizons by acquainting him with the computer as a new tool and with its possibilities.

D. Introducing the student to career possibilities in this area.

E. Giving students an appreciation of work done by the computer and its role in a free society.

F. Motivating students who might not otherwise be motivated.

3) **Computer-Assisted and Computer-Managed Instruction:**

Basic Skills: The individualization of instruction has long been the goal of education. The School District is concerned with enabling each student to work at his own rate, developing self-direction for learning, fostering the development of thought processes, and encouraging self-evaluation and motivation for learning. Two approaches have been adopted in development of individualized instructional programs.

Computer Assisted Instruction (CAI): The pupil sits down at a learning terminal and receives his instruction through the computerized program. Consistent with the theory of programmed instruction, each step in learning demands an active response, the answers are immediately evaluated, and feedback is instantaneous. By counting and classifying each child's errors as they are made, additional practice and remedial training can be provided right on the spot. Currently, programs in Reading and Mathematics are in operation utilizing the CAI approach.

Computer-Managed Instruction (CMI): The pupil does not work directly with the computer, but he works with materials that are designed to be managed and evaluated by the computer. The student may not be on-line with the computer system. In this approach the computer takes over the job of diagnosing pupil needs, assigning instructional sequences, utilizing a wide variety of instructional materials and audio-visual aids and evaluating pupil progress. In addition, complete class schedules and pupil evaluation reports are made available for teacher use in planning.

Simulation and Games: The capabilities of the computer provide opportunities for decision making and the use of teaching techniques not easily experienced in the classroom.

Secondary School Curricula: In the subject areas of Algebra, Biology, General Math, Chemistry, Latin and Reading, selected students are taught, at their own rate of speed, with material suited for their needs. (CAI)

The computer is being used in Vocational Training in the fields of Consumer Education and Electronics. Programs are under development to teach clerical skills and repair of small appliances to handicapped students.

4) **Vocational and Career Education:** An extensive program to provide secondary school students with information on education, scholarships and career opportunities is being implemented in all secondary schools. The program presents a personal approach to each student as it attempts to analyze their individual resources, qualifications and desires.

Staff Development

Depending upon the complexity of the program, this component ordinarily includes the definition of program goals and objectives followed by training in actual program operation. Training usually includes both classroom-type and "on-the-job" training for the effective operation of instructional programs. In all programs, the personnel of the Division work towards:

1) Building positive attitudes of staff toward technology.

2) Assisting teachers in improving their skills and techniques.

3) Developing competence of teachers in implementing individualized programs.

4) Providing teachers with needed material, special supplies and equipment to implement new techniques.

Specific Programs in Operation in the Philadelphia Schools

The School District of Philadelphia established the Division of Instructional Systems in 1966 to facilitate and coordinate the implementation of computers in the instructional programs in Philadelphia. As has been noted above, wide and varied programs are offered. Two types of usage have been selected for further in-depth presentation: Computer-Assisted Instruction, particularly in the tutorial mode, and Computer-Managed Instruction. In CMI, the student may or may not be on-line with the computer system, and the processing may not be in real time.

CMI systems, not on-line, were developed by the System Development Corporation[7], the New York Institute of Technology[8], and the American Institutes for Research, working with the Westinghouse Learning Corporation (Project Plan).[9]

The School District of Philadelphia uses an on-line computer managed system which was developed by the American Institutes for Research for the School District of Philadelphia and installed as a prototype in one school. In 1971-1972, the program was expanded to five schools. In 1972-1973, two new centers were added. As of June, 1973, there were seven centers. Additional centers are in the planning stage.

The Instructional Management Program (IMP) is designed to ensure that each student masters the basic minimum objectives in basic skill areas set by and for the schools involved in the program. Learning takes place through independent study packets, student tutoring and professional tutoring. Each step in the learning sequence is prescribed by a computer algorithm which matches the learning packet to the needs and the learning characteristics of the student.

The program consists of three main components: an evaluation system which measures each student's learning characteristics and his mastery of the stated objectives; a curriculum bank of independent learning packets which are sequenced and coded as to objective and the various learning characteristics; and a computer management system which matches the learning activity to the needs and characteristics of the student.

Students are measured at the end of seventh grade on their mastery of 69 objectives. These objectives cover four content areas (communication arts, mathematics, science and social studies) and six "skill" areas (creative thinking, critical thinking, effective communication, effective social behavior, learning strategy and personal responsibility). They have been arranged in priority order. The measured learning characteristics include reading level, ability level, learning style (auditory or visual) and cognitive style (abstract or concrete).

Each participating student spends from **80** to **100** minutes per week in the Individual Prescription (IP) Center following the sequence of learning activities prescribed for him. He receives his "prescription" from the computer by typing information on the terminal located in the Center.

The student begins by selecting one of the highest-priority objectives in which he has shown a deficiency. He "activates" the objective in his record by typing his name or ID number and the objective number on the terminal. He is assigned a diagnostic test which will determine which topics in the sequence he already knows. He records the results of the diagnostic test on the terminal and receives his first "prescription" -- the packet which best matches his learning characteristics and is on the first needed step in the sequence leading to mastery of the objective.

When he finishes the packet, he takes a short Progress Test to show his mastery of the material presented. If he passes this test he is assigned to the "best match" packet on the next sequential step. If he fails this test, the Center supervisor decides whether he should repeat the packet, take another packet on the same topic, continue in the sequence, or temporarily switch to another objective. He records this decision on the terminal and receives the appropriate assignment.

After completing the sequence of packets within an objective, the student retakes the original "mastery" assessment. If, as is usual, he passes it, he records this information and chooses another objective from the list supplied by the computer. If he still fails, he is given tutoring by the Center supervisor or a student tutor until he can pass.

Students who have no deficiencies work on "enrichment" packets of their own choosing.

The 1972-1973 evaluation data indicates, for students receiving instruction in particular skill areas, the rate of success averages 85 percent. The goal of the program to bring students to minimum levels of mastery in defined basic skills is being met. (Table 1).

The School District of Philadelphia's initial efforts in CAI were in the development of tutorial programs in Biology and Reading. These courses were chosen because of the need of urban students to improve their reading skills and because Biology is a required subject for all students. A team of curriculum writers was assembled, consisting of classroom teachers, psychologists and subject matter specialists. These people worked with programmers and other technical personnel to develop the material. After one year's operation, a published study compares achievement in Biology and Developmental Reading with students in traditional instructional classes.[10] In reading, the CAI classes performed significantly better than comparable students in traditional classes. Differences in achievement were not obtained between the CAI and traditional Biology classes. This was attributed to computer down-time and a lack of sufficient content validity in the standardized Biology test. An attitude survey constructed for the project indicated that the pupils liked working with the machines but were frustrated when the system did not function properly. Since this was the first large tutorial program in operation in a school system, problem areas were not unexpected. The following comments express the reaction of most of the teachers:

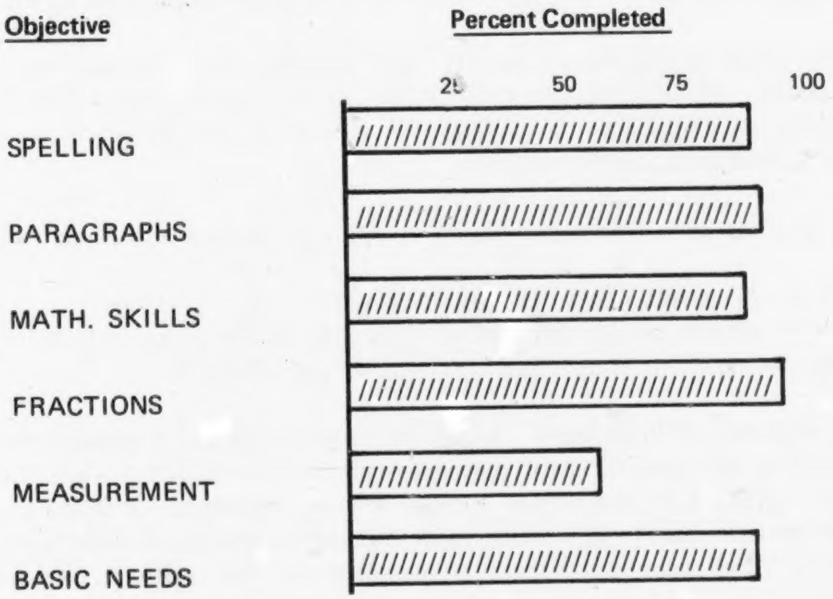
1) The program was experimental.

2) There are "bugs" and that "debugging" will occur as soon as possible.

3) The units of work are being constantly revised as a result of students' reactions.

Table I

INSTRUCTIONAL MANAGEMENT PROGRAM
RATE OF SUCCESS
FOR SELECTED INSTRUCTIONAL OBJECTIVES



The overall project objective was to expand from one to seven centers by disseminating the Instructional Management Program, in its entirety, to new centers. This objective was met. Fully operational centers are expected to continue as regular school programs. Data on achievement of instructional objectives indicate that the instructional model provides for a successful program. Instruction, designed to conform to an individual student's learning characteristics, past achievement history and present educational needs, ensured that each student mastered certain basic skills. Students were nearly always successful in mastering those skills in which they received instruction. Evidence of achievement in selected basic educational objectives is shown in the above figure.

4) The system is intended to supplant the teacher -- the "human brain" in no instance is meant to be replaced by an "electronic brain."

5) Teacher attitude can affect the success of the program. Teachers need to be **patient**, need to **believe** in the program, need to **grow** into the program which is an **evolving** one.

6) We are "pioneering" and have only begun to scratch the surface. We look forward, hopefully, to mastering techniques and processes that will demonstrate the increasing value of CAI instruction.

In the second year, no inferential statistics were reported. Only data of a descriptive nature were presented. In general, the trend in the results of standardized tests indicated that CAI classes were somewhat higher for both Biology and Reading. The system still did not operate well.

For 1970-1971, of primary concern was computer availability of 95 percent or more. This was not met. Comparisons were again made between CAI and traditionally instructed classes.[11] It was recognized that comparisons with respect to achievement must be interpreted with caution and not isolated from other "observable effects." The statistical comparison did favor CAI and a majority of both students and teachers preferred this method of instruction. It was viewed by the students and teachers as more individualized and personalized, and was considered by them to be highly motivating as well as a much improved program of instruction.

Due to the difficulties encountered with the computer system -- the system was removed and the curriculum translated for use with other hardware.

The CAI Reading Program is now part of an overall reading program. The criterion for acceptance of students in this program is that they read below their grade or capacity level, but are able to read fourth level materials with "adequate word recognition skills."

The curriculum is divided into instructional units or topics. Before a student begins a topic, he receives a brief pretest. Following the completion of the unit, he receives a posttest. If the student fails to achieve a certain degree of mastery (90 percent correct) on the posttest, he is sent back to study and review those areas in which he is deficient. He is then tested again for mastery. This procedure continues until the student learns the material adequately.

As part of the program, off-line instructional materials are provided to supplement the CAI instruction. Staff Development is an important part of the program. Teachers are made familiar with the:

1) Objectives of the program

2) Material covered in the program

3) Philosophy of CAI

4) Operation of the terminal which may range from 5-10 in any classroom

5) Use of off-line materials

6) Methods of classroom management.

The Biology material developed in 1966-1968 is also being used, but in a CMI mode. The translation of the material to this mode is not totally completed and many units have been modified so that instead of giving all instruction on-line, in a tutorial mode, the students are sent to materials off-line based on their individual needs. This method is still being evaluated.

To Summarize the Key Findings:

1966-1968 Enabling objectives accomplished. Hardware obtained. Staff recruited. Initial software developed.

1968-1969 Comparisons of achievement tests results between pupils taught by CAI and traditional methods showed CAI students tended to do better than controls.

1969-1970 Findings similar to 1968-1969. Because of "systems" failure -- hardware not operating at specified level, i.e. 95 percent of the time, no statistical tests were performed. A survey of students' opinions indicated that they liked working with the terminals, became bored less readily and had only **mild** dissatisfaction with the system.

1970-1971 Study of relationship between pupil personality and achievement in CAI indicated that specific personality traits were not significant correlates of CAI achievement. It was concluded that CAI could be used with most pupils.

1971-1972 The system failed to meet the established criterion of 95 percent available for students 82 percent of the time. Despite this, teachers reported positive feelings about the program and cited superior retention of students.

1972-1973 Change over from one manufacturer to another had a substantial impact. The hardware was far less sophisticated, but much more efficient. The program was extended from four schools to 14 schools, serving approximately 3,000 students. The system availability increased from 82 percent to more than 99 percent. The teachers and supervisors reported that CAI was continuing to be a strong motivating device resulting in substantial student achievement.

Some Major Concerns

Though we have made progress, there are problems which need consideration. For example:

1) We need to understand more about learning theory and the application of the principles of behavior modification, so that we can provide an organizational framework and then utilize all the methods and materials available to meet the objectives established.

2) High cost of equipment is still a deterrent for wide-spread use. Even though advances in technology have and probably will lead to greater reductions in computer costs, terminals and present-day communications costs still are high. With new kinds of communication devices being studied and mini-computers becoming more and more prevalant, needs of education must not be neglected.

3) Generation of material and distribution of material is being done in a haphazard manner. Personnel who are involved with the development of material must be granted the time and resources so that the end result will be worthwhile. Mechanisms must be developed so that the material can be evaluated and then made available for wide-spread use. The number of well documented comparison data is still somewhat limited, especially in the public school area. Also, this field seems to suffer from a marked time-lag in the dissemination of information about the development made in most projects. As yet, inter-institutional use of programs is still at a minimum. Problems of computer compatability have been a problem. Since programs developed for one computer system cannot easily be used with another system, the transferability of programs is difficult. Development of techniques for easy automatic translation from one language to another has not been possible.

4) Classroom teachers need assistance and time must be provided for this. They require training before and during the early stages of implementation of programs which depart from their traditional method of teaching an entire class by "lecturing."

5) There is still a lack of understanding by administrators on the benefits derived from the use of computers. It must be recognized by the administrator that changes in organization and personnel will be required and there is need for proper planning to effectively use the computer.

6) Reawakening of industry's interest to the potentials of the use of computers in instruction should occur. Industry has become more and more reluctant to invest in this area after their initial expenditure. As was stated in an article in 1971,[12] firms who have ventured in the field have not realized the return on their investment.

7) The future role of the Federal Government in developmental and operational programs needs to be defined. Have the programs been supported, evaluated and then disseminated?

What We Have Learned

The last ten years have seen many programs using computers begun, some failing and some continuing to exist and expand. We can enumerate some of the things we have learned. For example:

1) Teachers accept the aid of the computer because more effective utilization of their time is possible. However, they need assistance in classroom management.

2) Success of any program depends on adequate equipment. Operational reliability is of utmost importance. Unexpected interruptions and breakdowns are sources of frustration.

3) Prepackaged applications for instructional uses have contributed to students' gains in achievement.

4) Properly prepared course material in CAI can be used successfully with a wide variety of students. School districts can get assistance from universities, manufacturers, other school districts, etc.

5) Planning is essential, determining the objectives, preparing or selecting the proper instructional material, selecting the appropriate media, initiating and continuing a staff development program and then designing and implementing an evaluation system are steps that must be followed.

6) The academic community needs to prepare teachers for their role in helping each individual child explore more fully his own path of learning and his own capabilities.

7) The student must also be prepared to be concerned with his own instructional program and his role in an instructional classroom.

8) It will be possible to achieve systematic and efficient management of resources and facilities - not limited to matching students with instructional programs or to scheduling the resources of facilities of a school. We have learned the role the computer plans. This process involves teachers, facilities, curricula, and instructional modes in interaction with pupils' differing characteristics and needs to create a meaningful educational program using a variety of facilities and curriculum offerings in an efficient manner with all kinds of students.

CONCLUSIONS

A gross amount of misinformation has been disseminated about the "state of the art." Promises were made that could not have been fulfilled. The task of using the computer as a mass instructional tool, of developing a system of instruction, is more formidable than most of the educators had anticipated. We set ourselves unrealistic goals. What is available now are measurable results and valid statistics showing an increase in student learning through information released from schools in New York City, McCoomb, Mississippi, Chicago, Philadelphia, Waterford, Michigan, among others. Clark[13] states the most serious problems inhibiting the use of computers in schools are the lack of specialized programming and scarcity of research-based knowledge that will contribute to effective learning. Use of material developed by one school and used in another school district is almost impossible.

As new ideas and methods begin to develop, the sharing of successes and failures must occur. A catalytic agent is desperately needed. Greater utilization will spur production of equipment and materials into a sizable enough scale to bring about substantial reduction in costs. Major national programs must begin to depend upon nation-wide sources of talent to develop a framework upon which schools and school systems can build.

In the past, educators tended to buy off-the-shelf items complete enough to be operational by themselves without extensive contributive work by the user. Now, however, problems of developing the programs or providing staffs to implement them are expanding.

Judgment and decision must be made on the basis of extensive experience and expert analysis. The persuasion of rhetoric and the desire for institutional status can seduce schools into making large expenditures for equipment which may be poorly suited to their purposes or which they are ill prepared to use successfully. However, when planned for, the use of the computer in education will make a considerable contribution.

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ALASKAN SATELLITE SEMINAR

A Case History of Providing Teachers In-Service Training In Remote Rural Areas Via New Telecommunications Technology - A Prototype

by

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INTRODUCTION

In the past decade, telecommunications technology has offered the educational community alternatives for improving instructional productivity, or the means to overcome obstacles which would otherwise be insurmountable. Prototypes have been developed using cable television and satellites in many innovative processes, and some of these experimental projects have been reported in the literature.[1]

It is not intended here to present a survey of case histories in either cable or satellite experimentation, even if we choose to assume that sufficient data from these limited experiments under diverse conditions would warrant a comprehensive and rigorous analytical treatment at this time. What follows is a case history of what may well be the world's first satellite seminar for teachers, accredited by a university, and may serve as a catalyst for far-reaching developments in an environment most conducive to the application of satellite telecommunications technology to satisfy many educational needs.

The author wishes to acknowledge his indebtedness to Dr. Harold Wigren of the National Education Association who has generously offered his experience, observations and documentation of this satellite seminar for the substance of this case history. The author is grateful to Dr. Ray Barnhardt, the Satellite Seminar Coordinator, who has given his kind permission for rather extensive quotation from his reports. It should be emphasized that the material contained herein represents a preliminary finding of a pre-development phase, and the purpose of its exposure here is to raise issues and provide exchange in the broader context of future development of educational technology in Alaska. It is hoped that the second phase of this pre-development model (1973-1974 school year) will verify these preliminary findings, clarify issues and resolve some of the problems.

BACKGROUND

The Satellite Seminar entitled, "Teaching Techniques for Rural Alaska," is an outgrowth of a recommendation from a 1972 NEA-UNESCO study of the educational requirements of Alaskan villages and how telecommunications technology might help to meet those critical needs. As the report points out, "In many respects a satellite was invented for Alaska because of Alaska's unique communications problems, lack of terrestrial communications facilities, mountainous terrain, harsh climate and sparse population. . . .It is an ideal system for reaching all parts of the state on a real time basis."[2] The unique potential of satellite communications for Alaska, especially in the rural environment, is well recognized.

The in-service project was given further impetus by a subsequent and comprehensive survey of a wide range of rural educational needs and facilities inventory by Teleconsult, and a preliminary exploration of possible telecommunications and educational technology to satisfy those educational communications needs so identified.[3]

The in-service teacher project relates to a wide spectrum of proposed programs which can probably be served by similar satellite technology. The following summary of Teleconsult findings, coupled with a preliminary prescription of programs, brings the broader relationships of the project into focus.

Summary of Findings[4]

The common and most persistent needs of Alaskan rural communities in all regions of the state were explored in six categories: early childhood, elementary, secondary, higher, adult education and professional training of teachers and other rural workers. They are:

1) Development of self-concept and pride in heritage

2) Development of personal communication skills (verbal abilities and reading comprehension)

3) Career education -- preparation for gainful employment

4) Civic education -- knowing laws of land

5) Health care, mental health and sanitation

6) Consumer education and business methods

7) Utilization of leisure time

8) The increased holding power of the schools

9) Training of natives as teachers and health aides

10) Better communications between villages -- people to people, people to government

The teachers' in-service program clearly reflects the specific needs (8 and 9 above) of the Alaskan rural setting. These needs were translated into concrete programs based on the following guiding principles.

A. In all programs, every effort should be made to:

1) Increase relevance of materials

2) Counter isolation

3) Increase parent and community involvement

4) Develop possibilities of self-instruction

5) Equalize educational opportunities between rural and urban Alaska

6) Share scarce resources with remote villages

B. Use techniques such as:

1) Local production

2) Cross-cultural emphasis

3) Communication from and to natives

4) Adapting materials for self-instructional use

5) Parents as teacher aides

It can be seen that the teachers' in-service program is designed along the line of A-1, 2, 4, and 6 with techniques of B-1 and 4 prescribed above.

The proposed programs were classified according to the following categories:

A. Teacher in-service

B. Native culture and pride

C. News: local, state, national and international

D. Language development

E. High school completion

F. Pre-school

G. Consumer education

H. Leisure time

I. Careers and jobs

J. Health and safety

K. Foods

L. Business and economics

M. Mental health

N. Adult and parent education

O. Communication needs

P. In-school curriculum needs

Q. Citizen participation in government

The preceeding programs have been described in tables depicting WHAT is needed, to WHOM it is addressed, WHERE it might be originated, WHEN and with what frequency such needs arise, and finally, the ultimate ENDS which the programs are designed to achieve. As an example, the programs for teachers in-service are included in Exhibit A.

An attempt was also made in the Teleconsult Report to sketch a tentative television-radio schedule in accordance to the whole array of programs, as shown in Exhibit B.[5] To establish the daily requirements and circuits needed, a tentative weekly distribution of programs was prepared based on the following assumptions.

A. School hours start at 09:00 and end at 15:00; one hour for lunch from 12:00 to 13:00

B. One full day with no activities (tentatively Sunday)

C. From 16:00 to 20:00 (when required) for teacher and adult programming

It appears that one video channel plus the required audio channels will be sufficient to satisfy the needs for the educational program envisioned.

The reader may recognize that the satellite seminar experiment described herein reflects certain basic features of several of the recommended programs (e.g., A-1, A-2, A-3, A-6, and A-7). The in-service program was initially planned for 15-18 hours. However, due to the time constraint of the ATS-1, the experiment has to be conducted during 19-20 hours. It is felt that the enrollment would have been greater if the course were offered at an earlier hour.

THE PROTOTYPE

The objectives of the experiment can be stated as follows:

1) To demonstrate the feasibility of using satellite communications as a vehicle for increasing the professional competencies of teachers in selected, remote, isolated villages of Alaska.

EXHIBIT A

PROPOSED EDUCATIONAL PROGRAMS FOR IN-SERVICE PRESCRIPTION

WHAT	ORIGINATION DESTINATION	TIME FREQUENCY	END
A. TEACHER IN-SERVICE			
A - 1 Professional development experiences for the 100 new Alaskan teachers & those who are being transferred to new regions of Alaska. These training programs would provide information about the culture, village life, life style, value systems of residents, community power structure & the whereabouts of Alaskan backup teaching resources.	Univ. of Alaska Fairbanks/Anchorage New teachers in Alaska & teachers being transferred.	Min. 2 weeks prior to beginning of school & during 1st semester once per week	Avoidance of cultural shock; better school-community relations, improved education through more appropriate village understanding and teaching techniques.
A - 2 Teacher forum - a two-way exchange of ideas and questions & answer opportunity between teachers and teachers, teachers and "experts," and between teachers and administration support services. Teachers may "call in" problems, questions. Answers or suggestions given within 5 days (perhaps RFD Wisconsin experiment has tested procedures that could be considered).	e.g. Barrow/Bethel Wainwright/Barter Island Kotzebue/Nome Kotzebue/Barrow between teachers in villages with like environment	late afternoon or evenings twice weekly	Counter teacher isolation; provide immediate problem-solving help to teachers on their own in a strange environment.
A - 3 Teaching strategies appropriate for minority children.	Univ. of Alaska/Fairbanks All teachers in rural areas	After school once every other week	Improvement of instruction, how to get the most out of materials available as well as outside resources.
A - 4 Culturally relevant teaching materials and resources; what resources are available; where they can be obtained & under what conditions; how they can be used most effectively. The absence of relevant instructional materials has been especially hurtful in schools serving largely Eskimos, Aleut or Indian populations.	Univ. of Alaska/Fairbanks Teachers	After school, nights and weekends 2 per week	Improvement of instruction; isolation; continuing education while on the job.

WHAT	ORIGINATION DESTINATION	TIME FREQUENCY	END
A - 5 Effective utilization of educational technology in the classroom; how to use films, radio, television & other media with maximum effectiveness in the classroom.	Anchorage SOS Schools All teachers in rural areas	After school once weekly	Improvement of instruction; how to get the most out of materials available as well as outside resources.
A - 6 In-service program materials for teachers in each content area of the curriculum and in strategies of teaching.	Univ. of Alaska/Fairbanks All teachers	After school hours once weekly	Improvement of instruction; overcoming isolation; need to discard obsolete teaching methods & curriculum.
A - 7 Extension credit courses for teachers. These courses should be accredited with one or more of Alaska's universities or with universities in the lower 48.	Univ. of Alaska/Fairbanks Teachers	After school nights & weekends 2 per week	Improvement of instruction; isolation; continuing education while on the job.
A - 8 Minicourses for teachers, which enable teachers to rapidly acquire & improve their basic teaching skills in order to produce dramatic benefits in pupil performance. Minicourses can be either in-service or preservice in nature. The Far West Laboratory for Educational Research & Development has developed a series of teacher-training minicourses which might well be used with Alaska teachers.	No broadcast time needed Materials & tapes in each village Teachers	15 hrs. during the semester- about 3 hrs. per week for 5 wks. with monthly follow-up lessons to maintain & reinforce acquired skills.	Self-evaluation wherein a video recorder is used to produce tapes of a teacher's performance so that he might see himself at work with students & evaluate his own performance.
A - 9 A series of cultural heritage broadcasts dealing with social problems of a society in transition. Such a series could provide a summary of problems facing Alaska natives today. The broadcasts should open up suggested solutions to the problems if they are to be geared to the villagers as well as to the teachers who are newcomers in Alaska.	Univ. of Alaska/Fairbanks Teachers new to Alaska & native villagers.	Weekends or (if satellite communication is used) an indoctrination course for teachers	Acquaint teachers new to Alaska with problems facing Alaskan natives today.

EXHIBIT B

TENTATIVE WEEKLY DISTRIBUTION OF PROGRAMS

Hour	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
09 - 10	F - 1	B - 1	F - 1	B - 1	B - 1	J - 5	☒
10 - 11	D - 3	D - 3	D - 3	D - 3	D - 3	J - 3	☒
11 - 12						J - 9	☒
12 - 13	☒	☒	☒	☒	☒	☒	☒
13 - 14	C - 1	C - 1	C - 1	C - 1	C - 1	F - 1	☒
14 - 15	B - 2	B - 2	B - 2	B - 2	B - 2	G - 1	☒
15 - 16	A - 1	A - 2				☒	☒
16 - 17	A - 1	A - 2	A - 3 - 4	B - 4	A - 2	B - 3	☒
17 - 18	A - 5	A - 7	A - 6	A - 7	A - 9*	B - 4	☒
18 - 19	B - 5*	B - 6 - 8*	B - 7	C - 3	B - 7*	J - 1*	☒
19 - 20	E - 1	E - 1	E - 1	E - 1	E - 1	N - 6	☒

*Denotes bi-weekly or monthly programs

A.	Teachers in rural areas
B.	Native culture and pride
C.	News: local, state, national and international
D.	Language development
E.	High school completion
F.	Pre-school
G.	Consumer education
H.	Leisure time
I.	Careers and jobs
J.	Health and safety
K.	Foods
L.	Business and economics
M.	Mental health
N.	Adult and parent education

To simplify the distribution of subjects, the schedule was prepared under the assumption that all programs are one-hour long. Most probably, some programs such as News (C-1) will take up less time, giving added flexibility for any special requirements that may arise.

2) To demonstrate the effectiveness of using transcontinental satellite interconnection between two or more widely separated points to deliver information and obtain feedback and interaction between these points.

3) To stimulate the University of Alaska to use satellite communications in expanding professional growth opportunities for teachers in remote villages, thus making use of resources not otherwise available.

NEA, in conjunction with its state affiliate, Alaska Education Association and the College of Education at the University of Alaska, conducted a 16 week satellite radio series with teachers in 17 Alaskan villages. The program began on January 22, 1973 in the NIH studios at Bethesda, Maryland. NASA's experimental satellite, ATS-1, and NIH's satellite link-up were parts of the communication network. The series was offered for one credit under the title Education 494. Teachers could also audit the course which was coordinated by the Rural Teacher Corps Project, University of Alaska. The series was a two-way experiment so villages could talk to villages as well as to the University of Alaska and three NEA staff members who participated at 12 midnight Washington time (7:00 P.M. Alaska time) from the NIH facilities in Bethesda. The final program in the series was devoted to an evaluation of the experiment.

SUMMARY OF EVENTS

Planning

Preparations and planning for the satellite program began in the fall of 1972 with a series of open discussions, via satellite, regarding needs and possible directions the program might take for in-service instruction of teachers. These discussions between a representative group of teachers in the villages, NEA personnel in Washington and Alaska, and University of Alaska staff resulted in guidelines for a "Satellite Seminar" program for the Spring Semester, 1973.

On January 4, 1973, a number of persons from the Fairbanks area with potential interest in the satellite program were called together by Dr. Charles K. Ray (Dean, College of Behavioral Sciences and Education, University of Alaska) to discuss local participation in the project. At this meeting a steering committee was established and Dr. Ray Barnhardt, Head of the Alaska Rural Teacher Training Corps, was designated as the coordinator for the project. A memorandum requesting the participation of educational personnel in the nineteen communities presumably equipped to receive the program was sent out on January 9, 1973. It included an initial list of topics to be included in the program. During the remainder of January, the coordinator recruited rural classroom teachers and University faculty to prepare the present topics recommended by the steering committee and the teachers participating in the open discussion sessions in the Fall.

On January 22, 1973 the series began. Following approval by the steering committee, a final schedule of topics was distributed to all participating communities on February 5, 1973.[6]

Execution

A portion of the participants reported that they had wrapped themselves in blankets during the first broadcast. Eight of the villages are on or above the Artic Circle, and the temperature in some villages was as low as 50 degrees below zero. Numbers of school buildings where groups met were not fully heated since the radio sessions began at 7:00 p.m., which is several hours after dismissal of school. In other villages teachers met in hospitals.

Participating villages -- termed "earth stations" in satellite radio parlance -- were in an area stretching from Barter Island, which is offshore in the Beaufort Sea, to Nome and Kotzebue, a short hop from the Soviet border, and inland to such places as Fort Yukon, Allakaket, Anaktuvuk Pass, Artic Village and Chalkyitsik.

When the coordinator called the class to order each week, receiver- sender sets in his control in Fairbanks, the Alaskan villages, and the capital city of Juneau were all tied into the two-way radio network with Bethesda, Maryland. Resource persons included practicing teachers, in any of the villages, who described some instructional method they had found especially successful in rural areas; professors from the Department of Education, at the University of Alaska in Fairbanks; Alaska Education Association staff members in Juneau, and NEA central staff members and guests using National Institutes of Health facilities in Bethesda. Any participants from the Bering Sea to the Washington, D.C. suburb could take part in the question-and-answer period that concluded the 50-minute sessions. Thus, the exchange could originate about 6,000 land miles and nearly 50,000 space miles apart.

The first seminar session included an interruption which illustrates another facet of the satellite network. A health aide in Stevens Village came on the air to seek emergency medical assistance for a villager with intense urinary problems. A doctor located in the participating village of Tanana was summoned to the radio booth there. Participants throughout Alaska and in Bethesda listened as the doctor diagnosed the case on the basis of the health aide's description of symptoms and the result of tests which were made during the program. Listeners were fascinated as the doctor prescribed emergency medication and finally helped arrange for the ailing man to be flown to a Fairbank's hospital. Here, the inter-mixing between the educational and health-case communications needs in remote rural areas is vividly displayed.

Evaluation[7]

An evaluative instrument in the form of a questionnaire was sent to all teachers who had participated one or more times during the 16 sessions. Thirty teachers submitted the requested information. Of this number, fifteen had participated in the seminar regularly; the other fifteen had participated in ten programs or less.

The tabulated responses from the 30 returned questionnaires revealed the following:

1) Twenty-one of our 24 respondents to the question, "Should the Satellite Seminar program continue next year?" responded "yes," the seminar should continue. One voted "no," one voted "not sure," and one "did not care."

2) Of those who did not participate on a regular basis, the question was asked, "Why did you not participate in the program?" These are some of the responses:

- It came at a bad time for me.

- School radio-satellite not operating.

- Radio room too cold in winter.

- After teaching 21 kids in Grades 5-8 all day, doing classroom preparation, and a couple of hours of administrative paperwork, I was not drawn to the radio by what I did hear -- a dull rehash by College (University of Alaska), Juneau (Alaska-NEA), Bethesda (NEA) of things theoretical. Felt the teacher exchanges offered more but the rooms were not any warmer.

- So much static on the receiver that it is too tiring to pick the intelligence out of the static.

- We got involved too late to follow the whole series.

- Did not know when the broadcast dates and times were.

3) Fifteen out of 25 respondents felt that the satellite program series has contributed to constructive changes in their work as teachers. Among the items they listed as ways they had benefited from the satellite series were these:

- New ideas on individualization.

- A fund of ideas for the classroom.

- Helped me plan a non-graded curriculum.

- Gained more impetus to achieve results in the classroom.

- More work on individualization and non-gradedness.

- A better understanding of open education.

- Helped me better understand the Bush Teacher's problem and further convinced me that the satellite is the answer.

- I have used some of the ideas other rural teachers have used in their classrooms.

4) Twenty out of 23 respondents voted "yes" to the question: "Does satellite communication offer sufficient advantages for instruction over other forms of communication (mail, land radio, telephone) to warrant the additional expense?" There were three negative responses. Other responses to this question were:

- More people can interact. "If you could not talk to the people, it would not be any good." It reaches more teachers.

- Transmission could usually be better than land radio and much quicker than mail. Probably less expensive than telephone. (Telephones are not available in most villages.)

- Instant feedback. It is almost as good as being there in person, and it can include the whole state at once.

- Quicker than mail -- more spontaneous. Better reception than land radio. Cheaper than telephone.

- The immediate feedback and specific response available is fantastic.

- There are no telephones; radio has been impossible this winter.

OBSERVATIONS

The Mode

The satellite seminar for teachers in-service is a prototype in applying a new telecommunications technology to facilitate a traditional instructional service; e.g., "problem-solving" in a rather unique environment. Throughout its conception, planning and development, it was primarily an "in-service," "continuing education" and "career education" for teachers serving under the "poverty of isolation."[8] It was intended to: a) help new arrivals to gain insight into the problems of teaching in Alaska, b) make effective use of long hours during winter months for self-improvement in a manner similar to experiments which have been conducted with video tapes and CCTV for individuals temporarily isolated from the society in the armed forces, especially in submarines, and in prisons, and c) provide communications between isolated teachers with their peers in the "lower 48."

To provide teachers with in-service training is nothing new or unique, and the educational community has ample experience and competence in achieving satisfactory results among various groups of the target audience. However, in the case of Alaska, the application of satellite technology is perhaps the only way to bring about a "gathering" of people. An atmosphere of audio-interactive, instantaneous, and spontaneous exchange of ideas and experiences does much to overcome the problems of separation by vast distances. The issue raised is whether satellite communications offer a feasible and satisfactory means to accomplish the prescribed objectives in an environment where normal communications channels, e.g., telephone, land based short-wave radio and mail service are extremely inadequate.

There is an indication that the students are not ready to take full advantage of resource people whom they have not met. The additions of video facilities to the audio transmissions could provide the obvious remedy. Also, it is clear that satellite technology should not be applied in isolation. Discussion groups, tapes, textbooks and other materials should be used in parallel. Another essential is that a thorough planning effort, involving as many people as the situation warrants, be undertaken at the very beginning of program development. The investment made in the planning phase could provide significant dividends in assuring that the program be executed in an effective and efficient manner within the time and resource constraints.

Questions concerning the acceptance of satellite technology by the established educational institutions have also been raised. The propensity of educational institutions, administrators and faculty members to maintain the "status quo" against a threatening innovation has been observed, studied and well recognized for some time. In this case, the pilot project has been quite successful in progressing from one credit hour granted by the University to three credit hours in the second phase. The seminar coordinator observes that the satellite program should be built into the regular workload of the instructors instead of being carried as an overload.

The Interim Result

From the analysis of the responses to the questionnaire, it appears that the pilot project succeeded reasonably well in its intents to help new arrivals gain insight into problems of teaching in Alaska and assist teachers in self-improvement. The issue of "communications" between isolated teachers and their peers in the "lower 48" is a bit clouded. There is a general feeling amongst the rural teachers that their peers in the "lower 48" lack credibility in not possessing actual teaching experience in Alaska. Some typical responses are, "You are giving us answers for which we have no questions," or "We do not know what to do with the information you gave us." Here the "relevancy" and "applicability" of the materials dispatched from the "resource center" to the outlying recipients is called to question. ("Resource people are valuable to the program, but when they are not Alaska educators, they are not really aware of our situations and problems." "Outside resources are not aware of problems in small bush schools.")

On the other hand, one might entertain the suspicion of excessive "parochialism" or "regionalism" on the part of rural recipients. This is an issue not at all unique to Alaska and one that should command careful thought in promoting satellite education on any regional, national or international scale. It has been said that:

> The emphasis in satellite communications for schools should be on the sharing of excellence and diversity rather than the dissemination of mediocrity and uniformity. Not only can the satellite distribute high quality programs produced nationally, but it should also facilitate the exchange of locally and regionally produced programs of high quality. As such, it should become a means of fostering the pluralistic tastes and individual specializations of local schools, thus making possible a variety of voices, rather than a single voice, on a given topic. How best to achieve the proper balance between local, regional and national programs is a key problem in making satellites work for education.[9]

The proper balance is a key problem, and from this satellite seminar experiment in Alaska, it appears that this issue is indeed very real, if not crucial.

As the project coordinator observes, "At least one instructor who is intimately familiar with rural teaching conditions should be selected to direct the entire program as part of his regular duties. Since the program is directed to rural teachers, the instructors should have sufficient familiarity with rural Alaska to be able to relate the instruction to rural teaching conditions unless the topic is equally applicable in any teaching situation. Hopefully, the instructors will be selected on the basis of the types of training to be offered, rather than the availability of a given instructor determining the type of training. If the topic of the training program allows, a team-teaching arrangement between an NEA-Washington person and a person in Alaska might be considered. This would increase the resources available for the program."[10]

It also appears that having different lecturers on each session creates certain confusion. The preference is to have fewer lecturers with whom the listener must identify over a period of several weeks thus promoting closer student-teacher relationships and better exchange of information.

The same instructors should be available on the air throughout the program to provide continuity from one week to the next and to develop a familiarity between the instructors and the audience. The limited air time could be put to more productive use in this way.

Community Involvement[11]

Planning for future satellite programs should take place at a meeting in Alaska attended by representatives of the receiving group (in this case, rural teachers), NEA-Washington and/or Alaska, and the University. Although several persons from each of the above bodies contributed to the Spring semester program, the ambiguity of roles made decisive action difficult at times.

The coordinator occasionally found himself trying to reconcile three different sets of expectations; those of the teachers in the field, those of the university and those of NEA-Washington. These differences should be resolved prior to the program's inception. While a cooperative arrangement is necessary, final responsibility for the program must rest with a single person or body whose role is clearly defined in advance. Though the local steering committee has attempted to serve this purpose, it does not adequately represent all of the interests involved and, therefore, is unable to assume full responsibility for the program. The steering committee for future programs of the type just completed should include, in addition to the current members, several rural teachers and a person officially designated to represent NEA-Washington. Since travel costs would make periodic meetings of such a steering committee prohibitive, a planning group represented by the above mentioned interests could meet and prepare a detailed outline of the content and format for the program. This outline could then be presented to the full steering committee for approval prior to the beginning of the semester. The planning group might consist of three rural teachers, one NEA-Alaska delegate and the University instructors.

It is well recognized that there exist monumental problems in the coordination and planning for any satellite program. In the case of Alaska, the absence of a telephone in most rural communities, the unreliability of short-wave radio service, as well as the long delays in postal services tend to compound the complexity inherent in the planning process. These conditions make it less difficult to envision the problems to be encountered in any proposed regional or national satellite educational systems for rural communities in developing nations.

Training

Judging by the response to the questionnaire, it appears that special attention should be given to providing sufficient training for the operating staff to minimize such incidents as:

1) School radio-satellite not operating.

2) Radio room too cold in winter.

3) So much static on the receiver that it is too tiring to pick the intelligence out of the static.

Furthermore, the satellite program instructors should maintain close contact with the satellite technical staff. The lack of satellite broadcast dependability makes close contact between instructors and technical staff mandatory. Schedule and time changes, equipment breakdown and tie-in with other programs are but a few considerations in this area.

Economics

In recent years the economics of satellite delivery of education services have been examined in several studies. Many cost models were constructed based on certain assumptions with requirements. The application of a satellite delivery system to the Rocky Mountain and Appalachian states also yields cost information of considerable interest. With regard to cost, the Alaskan pilot project contributes little insight because the satellite ATS-1 was offered by NASA for cost-free use, as were the satellite radio facilities at NIH. Special antennas developed at the University of Alaska had been installed on the roof of the schools and hospitals in the Alaskan villages. Thus, the costs for such a seminar program consist largely of staff planning, time, honoraria to field the University instructors, etc. They constitute a rather modest sum as compared to a full-scale program serving a wide range of projects such as those depicted in Exhibit B. When the use of commercial satellite services and additional ground stations becomes necessary, costs obviously increase.

The expansion of this satellite prototype into the whole spectrum of other education programs, both video and audio, will require a critical examination of the cost-benefit trade-off, system engineering, and the statewide overall telecommunications system development plan. The multitude of domestic satellite systems to be completed and operational in the next few years should offer unprecedented opportunities for the education planners to formulate optimum strategies in applying technology to improve productivity.

FOOTNOTES

1. For recent work in this area, see Annex A, Bibliography.

2. H. R. Cassirer and H. Wigren. Alaska: Implications of satellite communications for education. Serial No. 2198/BMS. RD/MC, (Paris: UNESCO, November, 1970, p. 2 (mimeographed)).

3. A study of the potential of telecommunications and educational technology to satisfy the educational communications needs of the State of Alaska. Teleconsult, Washington, D.C., 1972. (OEC 0-72-0686).

4. Ibid., p. II-48.

5. Ibid., p. V-3.

6. See Annex B, Satellite Seminar Schedule, Spring, 1973.

7. This section is taken, largely, from NEA internal document on preliminary project evaluation by Dr. Wigren, May 18, 1973.

8. A term used by Marjorie Lynch, a federal official charged with improving the coordination of federal programs in the Northwestern States, in Associated Press News Release, reported on KFRB, Fairbanks, Alaska, March 16, 1972.

9. L. P. Grayson, F. W. Norwood and H. E. Wigren. Man-made moons satellite communications for schools. NEA, 1972, p. 43.

10. Dr. Ray Barnhardt's Final Report.

11. This section is taken largely from Dr. R. Barnhardt's "Final Report."

ANNEX A:

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The series of reports prepared by the Rand Corporation under the National Science Foundation under the title "Cable Television" (R-1133-NSF to R-1144-NSF) provide the most up-to-date source materials and case history on applying cable technology for educational purposes. The Bibliography contained in R-1133-NSF appears to be the most comprehensive compilations of source references.

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DISCUSSANTS' REMARKS

Representing State Departments -

Joseph L. DiStefano, Director
Bureau of Instructional Technology
New Jersey Department of Education
Trenton, New Jersey

Representing Chambers of Commerce -

W. Thacher Longstreth, President
Greater Philadelphia Chamber of Commerce
Philadelphia, Pennsylvania

ANNEX B:

SATELLITE SEMINAR SCHEDULE, SPRING 1973

January 22 - "Open Classrooms: Suggestions on How to Get Going."
Dr. Robert McClure, NEA, Washington, D. C.

January 29 - "Open Classrooms in Rural Alaska"
Mike DeMarco, CNER, University of Alaska

February 5 - "Self-Responsibility and Learning"
Sandy Hamilton and Bob Maguire
ASOS , Allaraket, Alaska

February 12 - "Children as Teachers"
Gaylen Searles, Alaska Rural Teacher Training Corps
University of Alaska, Fairbanks

February 19 - Holiday

February 26 - "Non-Graded Approach in Tanana"
Eileen Crooks, ASOS, Tanana
Ann Howard, ASOS, Tanana
Rudy Howard, ASOS, Tanana
Max Meeker, ASOS, Tanana
Judy O'Donnell, ASOS

March 5 - "New and Pending Legislation Affecting Rural Schools"
Bob Cooksey, NEA-Alaska, Juneau
Dr. Marshall Lind, Commissioner of Education, Juneau
Senator Terry Miller, President of the Senate, Juneau
Dr. Helen Beirne, Chairman of House, Health, Education and Welfare Committee, Juneau

March 12 - Continuation of February 26 presentation, plus:
"Problem Learners in the Non-graded Classroom"
Mary Moses - ASOS, Tanana

March 19 - "This Works for Me"
Karen Clark, Alaska Teacher of the Year
Two Rivers

March 26 - "Language and Learning in Rural Alaska"
Dr. Michael Krauss, Alaska Native Language Center,
University of Alaska

April 2 - Continuation of March 26 presentation

April 9 - "Effective Teachers of Indian and Eskimo Students"
Dr. Judith Kleinfield, Center for Northern Educational Research,
University of Alaska

April 16 - "Views from a National Perspective"
Mrs. Catherine Barrett, President, NEA
Rep. Don Young
Dr. Harold Wigren, NEA, Washington, D. C.

April 23 - "Teaching Strategies for Rural Alaska"
Dr. Charles K. Ray, College of Behavioral Sciences and Education,
University of Alaska

April 30 - "Community Involvement in Education"
Jim Williams, ASOS, Ft. Yukon
Carolyn Peter, ASOS, Ft. Yukon
Bill Pfisterer, ARTTC, Ft. Yukon

May 7 - "Emerging Trends and Issues in Rural Alaskan Education"
Dr. Frank Darnell, Center for Northern Educational Research,
University of Alaska

May 8 - Final Evaluation Session.

JOSEPH L. DI STEFANO'S REMARKS

I can not help but react as a parent and taxpayer. So much of the questionning that arises in my thinking, provoked principally at least by Sylvia Charp's presentation, would revolve around cost.

You made statements such as: there were 17 programs in Philadelphia; 70 schools; and 50,000 students. Question: How many schools, in total, are there? How many total students are there? In other words, how many students are these programs affecting?

In one particular case you cited 60 students and 32 terminals with one teacher and one aide. What is the total cost in a situation like that, and what is the cost per child in implementing that kind of program?

Question: What is your total budget and what was your start-up cost initially? These are the things from the state level that I would think of.

Who developed the software and at what cost was that developed? How large is your staff? Can the city ever pick up the 70 percent you are getting from other sources? And if not, why did you start?

To react to the paper itself, I prepared a few comments, and I guess the comments pertaining to the use of computers in instruction are related directly to the position that the New Jersey state government takes in the implementation of the concept. While everything appears to be technologically sound, there are some serious considerations implicit in the direct use of the computer with the child. There is no question that the cost/effectiveness of utilization of the computer in management has been proven time and time again. Will the computer prove to be as effective in instruction?

When one begins to talk about things directly relating to the use of the computer for computer literacy, it would appear to be educationally valuable. Everyone in our society ought to know what the computer is and what it does and how it affects our lives. It should be an integral part of the curriculum, and, therefore, a very important aspect of the total educational process.

Problem solving, on the other hand, while it is an excellent means of having young people interact with a complex machine and discover problem solving techniques and systems analysis, it also enhances proficiencies in the areas of Mathematics and Science most particularly. And having seen that with young people at the high school level, I think it has great value.

One serious question, however, is cost. What are the costs involved in setting up the problem solving terminal that students can interact with? When reference is made to 10,500 students and 80 teachers in many subject areas involved in the program, what segment of the total population is 10,500 students? What segment of the total teacher population is 80 teachers?

When indicating that it helps motivate students who might not otherwise be motivated, a very serious problem arises, in my opinion. The degree of sophistication required to deal with problem analysis by virtue of its very nature requires a more intelligent youngster and perhaps even a self-motivated youngster. And, I might add, wouldn't it be nice to have one of those students with us here today to respond to our concerns?

When we start talking about Computer Assisted Instruction I have a very serious question, the question of dehumanization. When a child sits down and reacts with a machine and the machine in turn reacts with the child, where is the human touch? Where is the diagnostic judgment of the classroom teacher? Where is the humanistic pat-on-the-back reward system that is so necessary in the instructional process? Where is the encouragement of one human being to another?

These are all very simple questions but these are the kinds of questions that are constantly asked at the grass roots level.

When one speaks of Computer Managed Instruction, I think here for the first time we have an area that, like its application in management, can be cost-effective -- although I do not know what the costs are necessarily. CMI certainly can relieve the professionals involved in the instructional process from a lot of insignificant trivia -- test grading, recordkeeping, data retrieval from records. This would allow the professionals more time to be at the human level of instruction -- one to one, the warm, compassionate and understanding level of instruction. I can not overemphasize that because I think this is where our biggest attack comes in the use of technology.

Simulation and games obviously is a very productive area, and I would think it is one in which there can be a great deal of value derived on the part of the youngsters. But here again the question is: 2,000 students a year out of how many in the total Philadelphia school population?

Under the secondary school system curricula the paper indicates that 7,000 students are taught. What is the total vocational population? They have a program that is being implemented for 200 students in four schools. What would it cost to expand and maintain that program?

Dealing with staff development and on-the-job training, the whole concept of developing programs for the professionals with the use of a computer is excellent. You are dealing with sophisticated adults who can adapt and adjust to the computer in a meaningful way because they are professionally in need of that which is being developed for them.

I might add that the only way one can increase or improve attitudes towards all forms of technology would be to employ technology when instructing those individuals whose attitudes need to be changed. This demonstrates the effectiveness and the necessity for technology in the classroom environment.

Of the systems described, the Instructional Management Program seems to be the most acceptable and the most logical system to institute across the entire educational community because it does several things. It first allows the classroom teacher to choose objectives or be at least knowledgeable of the objectives that are necessary for the student. It then enables the teacher to evaluate each student's learning characteristics and his mastery of those stated objectives. With the utilization of a bank of independent learning packets which are sequenced and coded to the objectives and a computer management system which matches the learning activity to the needs and characteristics of the student, one is able for the first time to do some meaningful measurement and be accountable for results.

With regard to CAI, having been a Physics, Chemistry and Biology teacher I can react to the Biology classes being taught with the computer. While it is understood that the program is experimental, there is reference to bugs and the fact that debugging will occur as soon as possible. What kinds of bugs are prevalent in a situation like this? And while it is understood that the human brain is not to be replaced by the electronic brain, how do you overcome the attitude of the teacher? How do you get the teacher to become patient and believe in a program and grow into a program which you describe as being an involving one?

Once again I can not help but continually point at the same concept. When you are talking about 600 students involved, of what total population is that? What are the costs involved? Multiply that cost times every student.

If this experimentally proves to be a more effective mode, does this mean that we can hire fewer teachers and divert that money into the use of the computer? Does it mean that on top of an already extremely high school budget we are now going to add the very expensive process of the use of the computer in education?

Then, of course, there is always the great danger in any kind of research when making comparisons of traditional modes to a different mode of instruction; that is, the motivation of a student learning Biology when exposed to an entirely new system, such as a computer as the "Hawthorne effect" sets in. They are going to succeed in spite of it. The youngsters would be more motivated and, in all probability, would tend to achieve better using a computer than a traditional mode.

There is also another obvious question: What is the traditional mode? Is it just a textbook and lecture method? If that is the case it may well be that we are not using an effective comparison. On the other hand, if the computer were to be compared to an instructional television mode, with a multimedia system, and you make a cost analysis of the Computer Assisted Instruction versus a multimedia instruction and still find that the achievement levels are significantly different, then we are talking an entirely different ball game. When one uses "traditional mode," I become very apprehensive.

One of the more serious considerations, of course, and the thing that is a great deterrent to Computer Assisted Instruction is software. The development of software for the computer and the manner in which it is programmed is a costly process. Since the market is very small, manufacturers and publishers have not entered this market place and will choose to remain out of it until it becomes apparent that it can be generally accepted. Therefore, the programming itself is minimal and not too terribly effective because of the lack of professional input from the commercial world.

To summarize, I think the uses of the computer are fairly obvious and their advantages ary also fairly obvious. The costs are questionable. Staffing in my opinion is the most important and the most critical aspect of any kind of programming or any kind of experimentation. The person who directs and the people who are involved ary supercritical. To get good quality people costs a great deal of money.

Frequently, then, from the state viewpoint at least, we find Boards of Education going into hardware programming of various types, shapes and forms, and then reaching down into their staff and saying, "You -- you are a Physics teacher. You ought to be able to do this. You Take over the process." This happens so frequently that it scares me when we start trying to perpetuate programs of this nature without alerting people to the fact that it is critical to have a topnotch human being at the head, and that costs money.

The key question that school administrators, classroom teachers and the whole educational community will ask is: What are we getting for our dollar value? Is it more effective than what we have? Are we, in fact, dehumanizing the curriculum as a result of instituting the use of the computer at the classroom level? And equally as important, how does the computer interface with the entire educational environment for maximum benefit to learners?

Dr. Ling asked some very important questions in his case history. Number one, can the new technique of satellite communications be readily useful to fulfill prescribed objectives in overcoming the environmental obstacles of isolation? When one begins to examine the alternatives to satellite communications it becomes obvious that our technology costs are too excessive when considering the mountainous terrain, the harsh climate and the sparse population of Alaska. The important question is what else can be done?

Decisions of this magnitude can only be implemented, in my opinion, at the Federal level. No single state can undertake such an endeavor. If we consider the midwest, far west and other areas of rural America, it becomes apparent that satellite communications can effectively serve the purpose. However, we await the jury.,

The second point is: Can such a technique be effectively employed for a wider range of educational purposes? Here again we find ourselves reaching into creative and resourceful minds for a multiplicity of uses to include the entire concept of Cable TV. How much easier would it be to reach people in their homes rather than having them travel to the central location? However when you are talking about a remote village of 19 people, I do not even know that that statement is appropriate.

Schools could be wired for special programming. For example, a series of lessons designed to meet the needs of Spanish-speaking children could be communicated between Florida, Texas, California, New York, New Jersey and anywhere else there may be a Spanish-speaking population.

This need not be confined to children. There is much that can be done with adults. The applications are only limited by the creative ability of the human mind.

His third point was: Can such a technique be economically viable and justifiable? I say yes. If we can justify space travel, we can certainly justify satellite communications in education. However, I think the college and university complexes of America are a critical link in the development of teacher training communications networks. By necessity, change must take place in the ancient institutions of higher education before one can expect effective communications to take place throughout the educational community.

Why not an open, teacher-training degree program or series, go-to-college-on-TV kind of thing? I feel that if we can get away from things like accreditation, certification, degrees, and start to think in terms of competencies of individuals and what they are able to do and how they are able to perform, we may be able to overcome some of these things that frighten us and get at the real basics of satellite communications.

W. THACHER LONGSTRETH'S REMARKS

Originally, I had an exaggerated opinion of what computer instruction was going to do. My exposure began five or six years ago in the IBM school, continued by going through Burroughs, RCA, Honeywell and GE. I have been through all of them, not only watching the manufacturing of the hardware, but also discussing the software and ways and means of how this might be applied to the learning process for both younger people and adults. This led me to believe that it was going to be a much more useful tool than it turned out to be, and that it would happen much more rapidly than it has.

Sylvia mentioned that reduced cost of instruction, or much better results, had to be forthcoming in order to justify the cost expenditures that were involved. Certainly neither of them were indicated, I think, either in the Philadelphia or Alaskan studies.

I would say that the results that I saw specified in these two papers would indicate, even with the relatively modest expenditures in both of them, that we really have not gotten very much for our money -- we being the government, a foundation, the school system involved, or the combination that was indicated there. And I guess that, if I were not a little bit more sophisticated in this direction, I would be extremely discouraged on the basis of what I saw. And that applies to some of the other papers as well.

I would suspect that perhaps the two most important factors I found in these papers and would like to share with you are these. First, there is the fact that we really have not gotten very far yet, and that for every two steps forward, we have had maybe one and three-quarters backward. The progress we have made in the last ten years has probably not lived up to the highly over-stated progress that was anticipated when we first began to realize the capacity of the computer and of some of the mechanical aids; that is when we began to think of technology in terms of accelerating the educational systems and, particularly, applying it in places like the urban areas, where we were in so much trouble with the traditional system.

The second factor is that, in spite of the fact that this has happened, it would be a fatal mistake for us to simply decide that because of this fact we ought not to continue to place money into this and to pour it in as heavily as possible. I am absolutely convinced that within this century, and there is not much of it left, we are going to find major breakthroughs through the use of the equipment that has been talked about today, and that some of these breakthroughs will be quite sensational in nature.

In World War II, we were able to learn to utilize mechanical devices. I remember particularly in aviation, where I was, the extraordinary things that were done, how rapidly they were developed, and how they really came from a very incomplete base in a short period of time. With the base of just the few things we have now such as the satellite, television, and some of the other mechanical contrivances that exist, we must be in a position where we can start to make some very real progress.

I am convinced that the business world feels very strongly this way. Obviously they have an ax to grind because they have money to be made out of manufacturing the hardware. But that is not all bad, because for that reason they are willing to invest in research on their own which, when added to the research that comes out of government or foundations, makes a very, very large piece of money available that would not otherwise be so. Also, because business people themselves recognize that due to their inability to find people with sufficient basic education to be trainable for a number of the existing jobs, ways and means of producing adult education internally must be found that are better than what we have now.

Already I see a trend on the part of business people to do it internally if they find they are not going to be able to get it externally. I would suggest that one of the great competitive educational systems of the next 20 to 30 years may be a General Motors Institution or a General Electric College or a Westinghouse University, or what-have-you, that will be in direct competition with the existing universities, state and private.

CASE HISTORY

FROM

INDIVIDUALLY PRESCRIBED INSTRUCTION (IPI)

TO

ADVANCED INSTRUCTION DELIVERY SYSTEM (AIDS)

A Case Study

by

Robert G. Scanlon
Executive Director
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DESCRIPTION OF INDIVIDUALLY PRESCRIBED INSTRUCTION (IPI)

Individually Prescribed Instruction is an instructional system that permits the teacher to plan and conduct a program of studies tailored to the needs and characteristics of each student. Its procedures have been designed to enable the school to meet the needs of more individual pupils and take a new direction in the continuing search for ways to adapt instruction to individual pupils. The rate of learning, amount of practice, type of materials, and mode of instruction are the parameters of individual differences emphasized in IPI.

During the school year 1963-1964, the Learning Research and Development Center at the University of Pittsburgh and the Baldwin-Whitehall public schools (a suburban Pittsburgh school system) initiated an experimental project to investigate the feasibility of a system of individualized instruction in an entire K-6 school (Oakleaf). This came about as a result of a series of exploratory studies begun in 1961-1962 designed to test preliminary notions in a single classroom. The work started with the use of programmed instruction in an intact classroom.

As work proceeded, it became apparent that the significant individualization feature of programmed instruction could not be augmented unless the organization of the classroom was changed to permit a more flexible context. Out of this experience grew the current Individually Prescribed Instruction project in which various combinations of instructional materials, testing procedures, and teacher practices are used to accommodate individual student differences.

Individually Prescribed Instruction is a system based on a set of specified objectives correlated with diagnostic instruments, curriculum materials, teaching techniques, and management capabilities. The objectives of the system are:

1) to permit student mastery of instructional content at individual learning rates;

2) to insure active student involvement in the learning process;

3) to encourage student involvement in learning through self-directed and self-initiated activities;

4) to encourage student evaluation of progress toward mastery; and

5) to provide instructional materials and techniques based on individual needs and styles.

The developmental model for IPI considered the following aspects of instruction as they relate to the individual:

1) detailed specification of educational objectives;

2) organization of methods and materials to attain these objectives, including a variety of paths for mastery of any given objective;

3) a procedure for the diagnosis of student achievement in terms of the educational objectives;

4) individual daily evaluation and guidance of each pupil, including a system for individually prescribing the learning task that the student is ready to undertake;

5) provision for frequent monitoring of student performance in order to inform both the pupil and the teacher of progress toward an objective; and

6) continual evaluation and strengthening of curricular and instructional procedures.

Specification of Educational Objectives

A structured curriculum has been built organizing instructional objectives in terms of levels and content area. Each subject area is divided into several content areas such as multiplication and division, and visual discrimination and vocabulary development. Each of these areas is further divided into levels of difficulty.

Two curricula have been developed that are specifically known as IPI. This includes Mathematics and Spelling. Reading, Science and Social Studies curricula have also been developed and are not specifically known as IPI. However, they have been developed following the same essential elements.

The various curricula are based on a carefully sequenced set of educational objectives which were used in planning most other aspects of the instructional system. Lesson materials, teaching methods, instructional settings, diagnostic tests, and the management and monitoring system are geared to the instructional objectives.

Organization of Methods and Materials

For Individually Prescribed Instruction to be effective, materials are needed that teach the objectives of each curriculum sequence. Therefore, all learning materials are correlated to specific objectives in the IPI continua and self-instructional materials for each objective are organized in a sequence. This sequence includes materials for review of prerequisite behaviors, teaching materials, testing materials and review materials. Teachers are provided with a standard teaching sequence for each objective. This sequence includes the special materials prepared to teach the objective as well as supplemental devices (filmstrips, audio-tapes, and other commercially available items) and manipulative aids.

Instructional materials are only one facet of Individually Prescribed Instruction. Attempts were made to correlate instructional techniques to IPI objectives. Individualization is not synonymous with isolation; therefore, independent study is only one technique used. Peer-tutoring, teacher-tutoring, small and large group instruction, and seminars play key roles in the IPI procedures; for example, small groups are formed when the needs of the individuals within the group are most alike. These groups are changed almost daily. The use of instructional techniques in a student prescription ensures the individualization of learning experiences for a student in IPI Mathematics. The techniques, differentiated by "settings" and "materials," help the teacher to tailor a learning experience to the individual student's needs.

Procedure for Diagnosis

A basic aspect of IPI is the detailed provision for diagnosis of skills and abilities of each learner entering the instructional situation.

Four types of assessment instruments are used in IPI. They include a placement test, used in locating students on a learning continuum; a pretest of each unit of work used to measure the specific objectives within a unit; a posttest of each unit to determine mastery; and a curriculum-embedded test measuring progress toward an objective.

Daily Evaluation and Guidance of Each Pupil

A unique feature of IPI is that each student's work is guided by a written prescription prepared to meet his individual needs and interests. The prescription is an important two-way communication link between the student and the teacher. The teacher communicates to the student the choices made in different materials and different instructional settings to achieve an objective. Information about student progress is communicated to the teacher through careful analysis of the prescription.

The development of the daily lesson plan or prescription for each student is a key function of the teacher in the IPI classroom. Having determined the student's placement on the learning continuum by means of the placement and unit pretest, the teacher then considers the materials available and the techniques of instruction possible for this objective. Further, the teacher considers the student characteristics as they relate to instruction. These characteristics include such things as his reading ability, his degree of self-direction and independence, his age or grade placement and his reactions to particular learning materials.

Monitoring of Student Performance

Charting the progress of each student as he advances through the curriculum and making these reports available to the teacher and student are essential aspects of IPI. This information is necessary for individual prescriptions and classroom management.

Information needed by the classroom teacher for day-to-day organization included: 1) level, unit, and skill of each pupil in the class, 2) the approximate length of time (in days) the student has been working on a given objective, and 3) the next immediate skill for each pupil in the class. The teacher uses such information to organize the classes for small and large-group instruction, peer-group activities, teacher-tutoring, or independent study. Most classrooms use a combination of these activities. Since the need of the individual is the starting point in IPI, the availability, accuracy, and format of these data are key ingredients to success.

Keeping day-to-day records and providing feedback information to both student and teacher are considered to be among the most important functions of the teacher aides because it frees the teacher to teach.

Continual Evaluation to Strengthen Curriculum

Individually Prescribed Instruction is viewed as an evolving notion. Critical in this system is a feedback mechanism that permits constant refinement and revision. The evaluation of IPI as an educational innovation must serve as an aid in its development, provide a basis for judging its success, and serve as a tool for the effective introduction into a new setting. During the development and trial of IPI, all components are monitored continuously so that the feedback can be used to suggest modifications. The developmental function served by formative evaluation is considered critical in IPI.

Cost Factors and IPI

Cost factors associated with the first year operation of IPI programs must include considerations of costs of 1) Pre-Adoption, 2) Training, 3) Material, and 4) Staffing.

Case studies of costs associated with IPI adoption in six schools during the 1968-1969 school year were developed. The schools selected represent a range of types and populations. Table I shows that the cost per pupil in 1968 in adopting the IPI Math curriculum ranged from $31.18 to $236.08.

Table I
Summary of Dollar Costs 1968-69

School	Pre-Adoption	Training	Materials	Staffing	Cost Per Pupil
(1)	$ 29.00	$1,417.50	$3,577.62	$ 5,064.00	$ 62.27
(2)	137.50	1,454.86	2,982.09	4,212.00	53.58
(3)	426.00	7,420.00	7,024.86	58,549.00	236.08
(4)	175.50	1,747.20	2,741.32	3,600.00	52.97
(5)	0	621.40	1,700.00	3,000.00	44.34
(6)	180.00	3,768.00	6,497.00	0	31.18

The overwhelming factor determining this range is the decision whether or not to hire extra personnel. The $31.18 school had no extra staffing expenses; the $236.08 school hired a full complement of additional staff. The following Table is a summary of dollar costs per pupil by cost items for six schools using IPI in 1968.

Table II

Summary of Per Pupil Dollar Costs 1968-69

School	Pre-Adoption	Training	Materials	Staffing	Cost Per Pupil
(1)	$ .18	$ 8.75	$22.08	$ 31.26	$ 62.27
(2)	.84	8.87	18.18	25.69	53.58
(3)	1.37	23.86	22.59	188.26	236.08
(4)	1.12	11.20	17.57	23.08	52.97
(5)	0	5.17	14.16	25.00	44.34
(6)	.54	11.25	19.39	0	31.18

Recalculating the same cost factors using 1973 information, the range of per pupil cost is $20.16 to $216.45. The reductions in costs have been achieved by reducing the material and training costs. Consumables now cost $6.50 per student. There also has been a slight reduction in staff cost due to improved management techniques. The following Table III lists 1973 dollar costs for the IPI Math program.

Table III

Summary of Per Pupil Dollar Costs 1973

School	Pre-Adoption	Training	Materials	Staffing	Cost Per Pupil
(1)	$ .18	$3.28	$17.58	$ 31.26	$ 52.30
(2)	.84	3.21	13.68	25.69	43.42
(3)	1.37	8.74	18.08	188.26	216.45
(4)	1.12	6.28	13.07	23.08	43.55
(5)	0	5.18	9.63	25.00	39.81
(6)	.54	4.73	14.89	0	20.16

Cost reductions from 8% to 35% have been achieved since 1968 for the IPI Math program. The specific reduction is as follows:

School	% Reduction
(1)	16%
(2)	19%
(3)	8%
(4)	18%
(5)	10%
(6)	35%

Per pupil cost information for other curricula is listed below:

Subject	Pre-Adoption	Training	Materials	Staffing	Cost Per Pupil
Science	$ 0	$ .90	$ 7.33	$.50	$ 8.73
Reading	0	4.16	51.15	.44	55.31
Spelling	0	2.08	3.61	.21	5.90

These cost factors are based on the first year's cost and do not reflect cost differences for the second and third years of operation.

Two critical questions concerning the funding of educational innovations have been addressed through the development of case studies of ten school districts using IPI programs. These questions include:

1) How does the availability of outside funding affect the adoption and diffusion of the innovation?

2) To what extent is a school district willing to assume on-going financial responsibility for the innovation?

The availability of outside funding appears to be a catalyst in the adoption of innovation. In eight districts, funding by an outside agency supported the costs of initial installation. In a ninth district, IPI Math was paid for with local funds; but IPI Reading, adopted two years later, was supported by Title III ESEA. Only one of the ten districts has continuously financed the innovation with no outside monies.

Monies from Titles I and III ESEA have spurred adoption. Title III grants (Project SOLVE and Project SKILL) have heavily financed IPI in two districts. Project SOLVE supports one district as part of a six-district consortium in an effort to make traditional programs "more humanized, more individualized, and more personalized." Both Project SOLVE and local revenues pay for IPI. In another school district, Project SKILL supported the first three years of IPI at the original site. This district is now using Experimental Schools Project (ESP) funds to help finance IPI. A combination of grants from Title III, ESAP (Emergency School Aid Program) and IAP (Instructional Assistance Program) helps support IPI in a third district. For 1973-1974, Title I will also provide funds in this district for expansion of IPI Reading and Math into grades seven and eight. Also ESAA (Emergency School Aid Act) will replace ESAP.

Title I has helped support the program in three other school districts. In one of these, IPI materials were originally purchased with monies from Follow-Through. Program maintenance costs are now being borne locally: in two schools, students in IPI pay a special "Tuition Fee"; and in the third school, all students pay a materials fee. In a second district, Title I continues to finance program maintenance, along with monies disbursed from central office. Another district was able to utilize Title I funds for initial installation, but now carries IPI costs as part of general instructional expenditures.

An interesting case is that of the district which, after adopting IPI Math with local funds, sought Title III funding to install IPI Reading. Representatives from the State Department of Education indicated to the principal that a proposal to incorporate IPI with the Individually Guided Education (IGE) model of organization would be favorably received. Because he was so interested in IPI Reading, the principal wrote the proposal, which brought in both the IGE format and the curriculum product. Though providing funding for only one year, the grant supported purchase of both consumable and non-consumable materials. Beginning in September, 1973, the district will assume all on-going fiscal responsibility for program maintenance.

Only one of the ten districts has funded the installation and continuous maintenance of the RBS currriculum products with no outside aid. Since we studied only districts that actually adopted IPI, we possess no data indicating how many districts would have adopted IPI but were unable to secure outside funding.

Evaluation

During the last five years, many studies assessing student achievement as well as student, teacher, and parent attitudes have been conducted. Generally the achievement results have been mixed. That is, no real pattern of high achievement appears. This is particularly true in assessing the outcomes of the Math and Spelling programs. Reading results tend to support higher achievement for the IPI students. It is fair to conclude that IPI students achieve as well as or better than non-IPI students on standard tests and achieve higher than non-IPI students on IPI tests.

Studies of Individually Prescribed Instruction and the affective domain on measures of self-concept, creativity, and attitude toward school have been conducted. The results show that IPI pupils have significantly higher scores than non-IPI pupils. In addition, the results of a parent questionnaire, to which the parents of both groups of students responded, indicated that IPI pupils are more highly motivated, more self-directed, and more independent than non-IPI pupils.

Teacher attitudes were also compared, using a semantic differential measure. The IPI and control teachers did not have significantly different perceptions of their teaching roles, the teacher/pupil relationship, or attitude about their students. The IPI teachers did have notably more positive responses than the control group only in terms of pupils' being independent and self-directed and in their perception of the teacher aide's role as productive and valuable.

The benefits observed over the past few years can be summarized as follows:

1) Teachers can replicate the system, thus ensuring system continuity for the learner.

2) Teachers develop positive attitudes, use data to make decisions, change their behavior in working with students, and provide valuable feedback for improvement.

3) IPI students achieve as well or better than non-IPI students on standard tests, achieve higher than non-IPI students on IPI tests, have a positive attitude toward school, and demonstrate a change in social behavior.

4) The system has produced encouraging results with various student populations.

COMPUTER APPLICATIONS AND IPI

Since 1967, RBS has been involved in applying computer technology to various IPI programs. Specifically, RBS has pursued efforts with the Philadelphia School District, Westinghouse Learning Corporation, The MITRE Corporation, Hewlett-Packard Company, and IBM Corporation. A brief review of each activity is presented.

Philadelphia School District (PSD)

Based on five years of effort in computerizing the IPI Math program, using Philco-Ford SAVI equipment, RBS and the Philadelphia School District made a unique contribution in two ways:

1) Mathematical content and utilization of learning theories.

   - Objectives were redefined and delineated into clear statements of the expected terminal behavior of the learner.

   - Each mathematical concept was exposed to careful analysis and review and carefully sequenced for interaction on the part of the learner with the SAVI terminal.

   - Deliberate attempts were made to emphasize the inter-relationship between the math concept expressed as symbols and that same concept in pictorial form. These perceptual and mathematical forms are each presented to the learner in a variety of ways.

   - Development from the simple to the more complex representation of content resulted in extensive use of iconic and symbolic modes.

   - Devices and techniques were utilized to captivate the learner's interest and motivate him to become excited about "what was happening and what would happen next."

   - Initiation and inclusion of games as part of the instruction were a logical outgrowth of planned efforts to motivate and propel youngsters through individual paths in the continuum.

   - Use of graphics and animation was planned to encourage greatest possible visual understanding of math concepts.

2) Utilization of computer capabilities to individualize instruction.

   - Every effort was made by the authors to explore multiple uses of the many faceted software capabilities to achieve the stated educational objectives.

   - A computer managed component was included to facilitate individualization of instruction and guide the learner through completely automatic, semi-automatic, and individually prescribed ways of proceeding through the continuum.

- Responses were deliberately planned to permit varying uses of light pen or keyboard techniques. The learner might use paper and pencil at the terminal or off-line and input the answers by the prescribed manner.

- Awareness of the software possibilities led to creative use of graphics and animation.

RBS and PSD combined efforts to answer the question: Can the IPI Mathematics Continuum be adapted to tutorial computer-assisted instruction? The answer which developed was definitely "yes."

To meet the primary objective of this project, initial field trials using the materials were conducted at three schools during 1968 and 1969. The initial testing of the placement tests began in March 1968 using city students in grades four, five and eight who spent one-half hour daily for about two weeks taking the tests.

Beginning in September 1969, 50 students in grades 2-6 at the Intensive Learning Center utilized the computer for diagnostic testing and instruction. Each year more students were introduced to the program with 200 pupils in 1971-1972. In the fall of 1971, about 70 students from the Pennsylvania Advancement School went on-line utilizing diagnostic instruments and instructional materials. The results of those on-going field trials from 1969-1972 showed that:

1) Utilizing the IPI diagnostic tests and instructional materials in tutorial CAI has resulted in pupils learning mathematics in a tutorial mode on a computer.

2) The computer can schedule automatically, semi-automatically or handle interactive updating and scheduling.

3) The students overwhelmingly enjoyed using the terminals despite technical difficulties. They even volunteered recess time to "go to the computers."

4) Sixty-minute instructional periods can be utilized.

5) A weakness was that the CAI-IPI functions best for children who can read. However, subjectively, it seemed that the major benefit of the program as it operated was the motivation value for children to read. Poor readers seemed to try harder and have less difficulty with the reading which was necessary in the on-line material than in other reading experiences. Students with serious reading difficulties could not handle the materials without considerable help. Some success was noted when two below average readers were paired together at a terminal. Additional aides were used to read unknown words to children during the second and third years. In the fourth year, experimentation was begun with one aide trained in CAI-IPI management procedures. The fifth year showed the results of this training.

In addition, four formal studies utilizing CAI-IPI at the Intensive Learning Center have been conducted:

1) Investigating the question of relative efficacy of two teaching strategies for feedback, Interactive (guided discovery) and Expository (exposition) resulted in no significant differences in interaction effects of treatment and sex. There was a significant difference at the .01 level supporting the conclusion that the program did contribute to learning.[1]

2) Examining the difference in performance between two groups of students using a different number of remedial branches showed that, based on the number of remedial paths accessed to learn a skill, the students achieved the same. The high remediation group took approximately one-half hour longer to complete the skill than the low remediation group, and the average time spent making each response was the same for each group.[2]

3) Comparing IPI pencil and paper and CAI-IPI based on the difference in performance between students learning a particular skill resulted in no significant difference.[3]

4) Studying the role the computer should play -- supplement to the regular teacher or major source of instruction -- results showed a significant difference in favor of the computer groups with no difference between the total and partial computer groups.[4]

Westinghouse Learning Corporation (WLC)

From April 1968 to March 1970, RBS and WLC prepared a computer managed system for the IPI Math and Reading programs. The objective of the Learning Management System was to provide classroom management information about the learning process of children.

The project was expected to include the following:

1) Collect, analyze and feed back to teachers and students individualized student performance data.

2) Integrate student performance data with the sub-system of student permanent records.

3) Develop and test a new format and processing system for student permanent records.

4) Collect, analyze and feed back to teachers data pertaining to their prescription patterns.

5) Correlate student achievement with instructional material segments for purposes of evaluation.

6) Collect and analyze information related to student learning styles.

7) Develop and test scheduling sub-systems to support the work of the teacher.

8) Collect, analyze and feed back data about each student on a continuing basis by skill mastery per level unit.

9) Develop feedback mechanism to teachers for appropriate student tests and mastery data.

10) Create and maintain a student data file for profiles, pretests, posttests, and curriculum-embedded tests.

11) Develop statistical summaries and normative data by school, teacher, and student.

12) Develop and test a data base and procedures for computer generated prescriptions.

13) Develop and test a data base and procedures for use by teachers in improving their guidance and counseling practices.

During the two-year period, a management system was built that did operate for fourth, fifth and sixth grade students in both Reading and Math. The cost of this system was approximately $25 per pupil. Staff reduction, an original goal, was never achieved.

WLC discontinued funding of this project due to a redistribution of their own resources and the inability to build a system that allowed for a changing curriculum.

The MITRE Corporation

In June 1970, RBS and The MITRE Corporation began exploring ways in which the MITRE Time-Shared Interactive Computer-Controlled Educational Television (TICCET) System could be integrated with Individually Prescribed Instruction. This effort culminated in the submission of a funding proposal to the National Science Foundation and the U.S. Office of Education.

MITRE and RBS proposed to develop the specific means to make practical and affordable the mass dissemination of individualized instruction. The proposed program had an initial four-year duration. In this time, major, definitive and measurable test results in two or more elementary schools, at least one urban (probably in Philadelphia) and at least one suburban (probably in the Washington, D.C. area), were to be obtained to allow the funders to decide the promise of this new total approach in meeting its stated goals.

The key to enabling low-cost, manageable and flexible individualized instruction was a breakthrough in the cost-effectiveness of Computer-Managed Instruction (CMI) and Computer-Assisted Instruction (CAI). Instantly available CMI to the teacher and to the student regarding both on-line (CAI) and off-line (other media) student activity and computer-generated prescriptions were to be used to drastically reduce clerks and clerical teacher duties associated with IPI. Computer-Assisted Instruction (CAI) and Computer-Assisted Tests (CAT) would allow uniform testing procedures and further reduce repetitive duties of the teacher, especially since the CAI was to be accompanied by great amounts of individualized voice instructions to the student as well as pictures. Enough terminals (128 per school) were to be provided in the field trials to allow each child one or more hours of terminal time per day.

In addition to dramatically improving the economics and manageability of highly structured IPI-like curriculum administration, we also proposed to implement the following innovations and improvements. First, the TICCET system would be programmed to be self-disseminating, that is, teacher and administrator training would take place under TICCET CAI and CMI by the end of the four-year program. Secondly, dissemination of updated versions of the curriculum would be performed by return of the school site computer disc packs to The MITRE Corporation in order to write new updated data for successive editions of the curriculum.

This proposal was not funded and the development never started. The TICCET system did receive funding from the NSF and further development aimed at community colleges. This work is presently under way.

Hewlett-Packard Company (HP)

During June, July and August, 1972, RBS and the Philadelphia School District investigated the feasibility and costs associated with providing computer support for HP hardware for elementary Mathematics in grades K through 8.

The materials studied for possible combination into an integrated mathematics instructional system available for use with computer systems which Hewlett-Packard produces were the Philadelphia School/RBS Mathematics Program, the 1972 IPI Mathematics, HP Instructional Management Facility and the Strands Drill and Practice Program.

The basic objectives of this study included:

1) Identify which existing instructional modules can be re-implemented for HP systems without substantial change in instructional approach, assuming the use of various terminal devices (i.e., teletype, teletype compatible cathode ray tube, cathode ray tube). In addition, develop an estimate of the manning effort required to accomplish the required conversion and estimate completion date based on the manning effort.

2) Determine the disposition of existing instructional modules which require substantial change in instructional approach or require other terminal devices or media (i.e., audio output, graphical CRT terminals, off-line materials, or other approaches). In addition, develop an estimate of the manning effort to accomplish the required conversion or development, and project the costs of use to a school district if special devices are utilized.

3) Identify which additional modules that are not presently developed would be desirable in a complete mathematics instructional system, and estimate the potential costs of development of these modules.

4) Recommend which of the modules should be revised to reflect the differences between the 1968 and 1972 versions of the IPI Mathematics continuum.

5) Identify, where possible, the capabilities required of the HP Instructional Management Facility to support the integrated program above.

6) Recommend a suitable method for integrating the HP Mathematics (Strands Drill and Practice) with the Philadelphia/RBS Mathematics Program.

To accomplish these objectives, the following work was completed:

1) Evaluation of the eight topics in the CAI-IPI program: Numeration, Place Value, Addition, Subtraction, Multiplication, Division, Combination of Processes and Fractions.

2) Evaluation of the placement tests and posttests.

3) Investigation of the method of conversion: BASIC vs. IDAF.

The results of this analysis show that there are approximately 21,000 question frames and 57,000 feedback frames in the entire program. Of the total 78,000 frames, about 13 percent or 10,000 frames need some modification. The estimated number of man days needed to accomplish the conversion is 1,408 days.

Since the CAI-IPI program is tutorial while the Strands Program is drill and practice, it was anticipated that many of the CAI-IPI skills would not match with any of the Strands objectives. Thirty-one percent of the IPI objectives have no comparable Strands objectives, seven percent match perfectly, while the remaining 62 percent match partially.

Hewlett-Packard is considering the feasibility and cost of such a conversion.

IBM Corporation

For the past two years, RBS, the Philadelphia School District and IBM have been developing a prototype stand-alone computer device. The primary purpose for the development effort is to provide an Advanced Instruction Delivery System (AIDS) that addresses the cost of delivery, authoring, development and distribution of instructional materials. It includes a personal instructional module that is one unit combining an audio-video cassette that has programming logic stored within the cassette. The delivery device features include:

A. visual-frame addressable,
B. color,
C. variable speed,
D. audio-stereo,
E. alphanumeric and positional response,
F. scorekeeping facility, and
G. on-line data collection.

An author's console is part of the system that provides for integration of A-V materials, audio source recording and control program generation.

The delivery device is a rear screen projection system using super 8MM color film to provide a high resolution color display. It is cassette loaded and has one hour maximum of audio frames. Each visual frame and each audio frame is uniquely addressable by the delivery device. The viewing screen is approximately nine inches wide and seven inches tall. The audio presentation is via a pair of headphones which can make use of both monaural or stereophonic sound.

The response mechanism to the delivery device by the student is a keyboard. This keyboard has the facility of generating a response to questions via five multiple choice buttons. In addition to the multiple choice response capability, it also has a complete alphanumeric constructed response capability. For single character responses, the means of entry is simply depression of the key selected by the subject. For applications such as spelling or the solution of arithmetic problems, the student simply enters his total response. As it is being entered, it will be displayed immediately above the keyboard. When the student is satisfied that the entry is correct, he will then depress a key in the lower right hand corner of the keyboard called 'START'. This terminates the entry to the delivery device and allows the system to go about checking this answer. He can erase the answer and enter a new answer at any time prior to pressing the start key.

The delivery device contains a powerful logic decision system which allows the checking of responses from the student and adaptive branching as a function of his answer. To provide the adaptive branching, a facility exists for internal record storage. This storage is accomplished by the use of counters. These counters may be incremented from any instruction in the program, and may be tested at any time to establish a branching scheme. The counters are displayable upon demand by either the student or the proctor on the front panel of the delivery device. The counter contents are displayable on the same display on which the student observes the input from his keyboard.

The delivery device has the ability to automatically signal the proctor (under program control) via a light on the top of the delivery device. This capability is enabled by the dispatch of the proctor call instruction.

One prototype model of the AIDS device has been built. A demonstration lesson teaching mathematics has also been developed. Several funding agencies are now considering support of the further development of the AIDS device.

CONCLUSION

Individually Prescribed Instruction has demonstrated that the systematic organization of teaching and learning coupled with the dimension of retraining of teachers and administrators does improve a school's ability to allow for individual differences.

Teaching procedures used with IPI differ somewhat from those used in conventional instruction. These can be seen in terms of contrasting questions which the teacher poses as he approaches the instructional situation.

Non-IPI	IPI
1. How can I explain this?	1. What should I have the student do to actually practice this behavior?
2. How should I address this group?	2. What kind of help does this pupil need to master this material?
3. What topic shall I cover today?	3. Where is each individual student in terms of the learning continuum?
4. What is wrong with these pupils that keep them from learning what I am presenting?	4. How can these materials and procedures be modified so that pupils learn more readily?

The contributions of IPI in terms of systematic organization and delivery of instruction have been significant. The history of education will credit this invention as a major aspect of improving American education. IPI is one innovation based on research which uses current information to improve its techniques, procedures, and materials. The success generated has provided significant insight into the age-old problem of providing an individual plan for each youngster based on his needs and characteristics.

Applications of technology to enhance this system have been substantial. These efforts have included investigation of both the delivery of instructional materials as well as improved management capabilities. Since IPI rests heavily on data to make decisions, further efforts are needed to improve productivity. Application of tecnnology will permit research to ask cost questions that are aimed at reducing staff needs. In the field of education, when one talks cost-effective, he really means less cost. If educational systems are in fact going to cost less, technology must be aimed at the biggest item in school budgets -- salaries. A device such as AIDS will at least permit research efforts in this direction.

FOOTNOTES

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DISCUSSANTS' REMARKS

Representing Teachers -

Eleanor Lonesome, Curriculum Writer
Instructional Computer Center
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Representing Administrators -

Orlando F. Furno, Assistant Superintendent
Carroll County Public Schools
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ELEANOR LONESOME'S REMARKS

At the outset, I want to state the opinion that the large majority of teachers are ready for technological approaches to teaching. Teachers realize that there must be a better way. The evidence is in and can no longer be ignored or refuted: too many children are failing to master basic skills. Many of those who do manage to read, write and compute to a satisfactory level are still not emerging as confident, self-directed learners -- which is one of our goals.

All of us in the field of education are accountable. We do have to come up with new techniques. It is incumbent upon teachers, no matter how insecure they may feel at first, to learn to use these new approaches.

Every teacher suspects that each of her students could make great progress if she could determine his individual needs and provide appropriate lessons for him every day. But how can she do this if all of her students are dependent upon her for everything they do at all times? She finds it quite impossible to cope, so she typically tries to make the best of what we call the traditional approaches. She supplements her teaching by making use of AV equipment and the various instructional aids that are commonly available. But she realizes that in order to truly individualize instruction, she, at the very least, needs diagnostic measures keyed to teaching materials which children can use independently or semi-independently.

The need is established and I believe the desire is established, but a teacher will be ready to make real changes in her methods only when she is convinced that another approach is manageable and that there is evidence that it can be used effectively with children similar in level of skill development and socioeconomic background to the children she teaches. Teachers in an urban setting, such as Philadelphia, are concerned that programs are being developed which are not suitable for the urban child who has low motivation, is low achieving and is not accustomed to directing himself through learning activities.

The decision to individualize usually brings with it the need to provide for a flexible classroom management pattern, as Dr. Scanlon noted occurred at the conception of IPI. This prospect is disarming to a teacher who has not tried it. Teachers want and require training in the more open classroom because complete dependence on trial and error methods is time-consuming and frustrating. A large part of this training has to do with how to help students to make the transition between learning modes and to work in an independent, more self-directed manner. It is a challenge.

Jack Edling in **Individualized Instruction: A Manual for Administrators** reports that teacher reaction almost universally is that there is more work involved in both initiating and maintaining individualized instruction. So the teachers are fearful of their ability to carry out a program where every child is perhaps working on a different lesson. Many teachers find that they can not cope with that kind of situation and ask to go back to a traditional classroom.

Pencil and paper IPI creates a dynamic and demanding role for the teacher. There is no way that this system is going to make one feel that he is being supplanted by technology. Faced with the key function of preparing a daily prescription for every child, it is necessary that the teacher be very familiar with the curriculum materials, instructional aids and the very technique of writing a prescription -- which brings us to the matter of teacher training.

I would be interested in the kind and duration of the training procedure for prospective teachers of IPI. I can not emphasize enough how crucial teachers feel this to be, especially in particular programs. I dare say that failure to adequately train teachers and teacher aides is one of the prime reasons for failure of pupils to obtain maximum benefits from otherwise good programs.

I would like to see teacher training courses structured like sequences for students -- with written objectives, activities planned for a path toward mastery of those objectives, and consideration for individual differences in the time and manner in which teachers learn. All teachers do not learn the same way, and sometimes the training period ends too abruptly for some of them because that is the way it was planned. Some teachers still are not ready, but have to go with it because that is the plan.

With IPI I can see that even with a teacher who has become adept at writing prescriptions, it still takes a lot of extra time to do that daily planning for every child. I would be interested to know how you handle that time allotment.

With primary responsibility for scoring student materials and tests, keeping day-to-day records, and providing feedback information to both students and teacher, the aides are quite essential and also must be well trained.

Questions teachers might ask are: Will I be responsible for training my aides? How many aides will be allotted for a class of 30-35 pupils? How many hours per day will I have the services of an aide? Will the principal be able to provide back-up assistance when my aide is absent?

The report notes that all components are monitored continuously, so that feedback can be used to suggest modifications. I would like to emphasize that teachers appreciate it when suggestions they make as users are implemented, and implemented rather promptly, so that they can benefit from their suggestions. When they make criticisms that prove valid, I think they should be considered when revisions take place.

I am wondering about feedback concerning the appropriateness of teacher-made prescriptions in IPI. How does this affect the number of remedial paths a student might have to take, and how might it affect his overall achievement? You say that the teacher can keep modifying a prescription, but I am wondering how many times a teacher makes a good prescription at first, so that the student does not lose time.

Achievement results, you say, have not been dramatic for IPI, that there is no record of high achievement. I am wondering -- without getting back to how much it costs -- how much a unit of learning is worth for a child and how long a project like this expects to be developed and funded before a pattern of high achievement is demanded by somebody. Do we have unlimited time to develop these programs before somebody says, "We have spent enough money. The kids are still not learning any better, so we are going to stop doing it."

Since availability of outside funding is so critical -- Dr. Scanlon noted that many times when federal funding is discontinued programs are dropped -- I wonder if, while the program is being funded, a school district or school might be able to purchase many of the materials and use their money for training teachers to replicate that system. Then, when the funding stops, they will still have a basis upon which to build their own program. In this way, we could continue to meet the objectives, for instance, of IPI and the whole scheme of paper and pencil activities. I wonder whether or not they could do that inexpensively enough to justify the money for teacher training.

The development of methods to make printed materials non-consumable while still providing for pupil responses might have an appreciable effect on costs, especially in programs where volumes of paper are used. You spoke of trying to do something in that direction, and that would seem very important to me.

It appears that a lot was learned by the developer during the process of applying computer technology to IPI. Incorporating the magic of television in a teaching sequence sounds like sure-fire motivation, and I am surprised and disappointed that a more significant difference was not shown. However, I understand that that was not a very broad study.

The computer-managed component is most desirable for reducing clerical tasks, especially in eliminating the need for the teacher to develop prescriptions. I can see that it would be reasonable to expect a trained aide to be able to manage a center where every child is interacting with the computer. In the paper, discussion broke off before I found out about the results. What happened when you had just a trained aide in the center with the children?

As a result of the experience with Westinghouse -- the CMI idea -- you said that funding was stopped. I wonder, when funding is stopped like that on a project, what happens to the idea? Is all the work lost? Does it just sit around some place until somebody else decides to fund it? It seems like such a terrific waste when the school district can not support it in some way. Especially after you have spent a couple of years working on a project and then see it stopped completely when Federal funding is cut off.

The proposed system with MITRE seems to have included all of the best features highlighted in the previous development associated with IPI, with the added feature of reduced cost. When the TICCET system is developed for community colleges I am wondering if that will become applicable on elementary and secondary levels. Will you still be able to use ideas gained in that development?

The AIDS device you described in your paper sounds like a good thing to be used in a program that has a remedial thrust.

I can not help commenting on a final point in Dr. Scanlon's paper because it keeps coming up again and again when we talk about technology in education. At the very end of his paper, Dr. Scanlon refers to reducing staff. This always occurs to teachers when you talk about technology. I just want to say that he really knows how to threaten a guy.

ORLANDO F. FURNO'S REMARKS

Before I react to Scanlon's paper I have a few comments to make which I think are pertinent to this topic. As an administrator and as a former person in research, I have to say that generally the data that I need for my operational decisions are really not forthcoming from research. When I need data for a decision I find that it takes weeks and months before we get it from research, and then the researchers are always very, very surprised to learn that we have already made a decision on something that they have the data on two months later. And then they wonder why we are always making decisions based on the seat of our pants.

I think you should be aware of the fact that administrators are not necessarily enthusiastic about educational technology. Take the telephone, for example, if I can use that as an illustration of educational technology. To me the telephone represents nothing more when it rings than someone about to give me hell or wanting money or calling me up at 1:30 in the morning and threatening my life. If you try to get an unlisted phone, then you are not communicating.

Also, you would be surprised at the number of federal and state reports. Every time there is a project you have numerous federal and state reports. Then you always have auditors coming in three years after the fact, berating you for not having the data to fill out these reports.

I was very interested in Ms. Lonesome's remark that teachers were ready for educational technology. I think I can truthfully say that most school administrators are not.

I look at many of my adversaries here. I look at the Chamber of Commerce. There I see an individual or organization that is continually criticizing us in the newspapers about why schools can not be more like business and why they can not run their enterprise in a businesslike manner. Then I read in **The Wall Street Journal** about hundreds of businesses failing every day.

Then I come to the politician and I see two things. He is always enacting laws that we have to administer to our people who do not want them. For example, accountability -- we are having a heck of a time in Maryland trying to administer accountability.

One of my functions is negotiations and I see an American Federation of Teachers' representative here. He is an individual who always seems to have a grievance to present to us, regardless of what it is.

So if you think that administrators are just running around with open arms to implement educational technology -- they are not, and for very good reasons. Many of the technology innovations that you are proposing we could not really support, either financially or in terms of the cost/benefits.

I would like to emphasize that the things I criticize are not directed at the authors of papers. In some instances later, not with this particular paper, I will disagree very violently with some of the material proposed. I would like to say to you that I am not disagreeing with you as a person. I am merely disagreeing with some of the ideas the paper presents.

Insofar as this paper is concerned, it contains a set of specified objectives upon which IPI is based and the instructional aspects that were considered in formulating this IPI model. I do not think the objectives listed in that paper are necessarily unique to IPI. I think the classroom teacher in a traditional situation has similar objectives. I would like to point out, though, that if I can believe what was in the paper, and I think I can, IPI is exceedingly expensive -- even from my own experiences.

We have in our school district a federally sponsored project called ACCEPT AND CHALLENGE. The purpose is to take students in early childhood -- ages four, five and six -- and evaluate their progress. To use a cliche, the people involved are supposed to accept the children as they are, wherever they presently are academically. This project involves the services of numerous professional staff people, such as psychologists, psychometrists and psychiatrists. The object is to get all of these people concerned with the learning process, so that they can accept the child as he is. At least that is what the project tells us.

That is the acceptance part. Now for the challenge. The team of persons then proceeds to write an individually prescribed learning prescription. The teacher then is held responsible for implementing this prescription. Successful? Sure. Our instructional people say so. The State of Maryland says so. Apparently the Federal government people were very hard pressed to find some project they thought successful, so that they could get some funds from Congress. So, they also said it was successful.

However, the cost per pupil is $3,500, and since budgeting lies in my sphere of responsibility I have to look at this. I find it very difficult to get three and a half times what we are spending per pupil to support this project throughout the system. In light of rising inflation, this is an impossible task. To try to convince politicians and irate taxpayers, who already believe that the schools are spending too much on education, I have as much of a chance of succeeding in getting three and a half times as much money as we presently have, (which is a $33 million budget) as I have in teaching shrimp to whistle.

But even if I could get the money, where could we get the competent professional personnel, particularly the so-called master teachers?

Let us look now at the materials in this project. I am not going to get into start-up costs or anything of that sort, but from what Bob Scanlon has presented I have the feeling that the IPI models proposed are so costly that neither taxpayers nor top level school administrators would consider this juice worth the squeeze. This is not to say that people in research should not be concerned with IPI models. They should. But we do not stand much of a chance as school administrators to finance present models. And it does not necessarily mean -- I would like to emphasize this -- that because you build a better mousetrap, it is not going to be accepted.

The acceptance of change is a very funny thing. Where you think people are going to derive a great benefit from something, you may not be able to implement it for various reasons, either political or because of unions saying "this was not in our contract." Many a project could not be implemented because of these things.

The techniques, then, are very, very expensive and also require perseverance on the part of various people; for example, on the part of the administrator to fund the project, and on the part of the teachers to get the results. Frankly, administrators in the main lack this perseverance. We are only human. We try to run with the foxes and bay with the hounds. In other words, we try to be on both sides of the issue. And, we are notorious for implementing projects on paper and with words.

The author stated that "the development of the daily lesson plan or prescription for each student is a key function of the teacher in the IPI classroom." I went over this. I happen to have been principal of a senior high school and I had a fetish then about lesson plans. Since most teachers then taught about six periods and had about 30 kids per class, this meant about 180 students that they were in contact with daily. I found when I was principal that very seldom did teachers, although they may be different today, have written lesson plans for a day, much less a week. So I really can not see teachers writing 150 individual prescriptions each day.

We grant right now about one free period. This would require 150 minutes. If you take 50 minutes of a period away from this, this still leaves 100 minutes. Can't you see the union rep coming right in administrator's door if we were to implement a project that would require teachers to spend 100 minutes writing individual prescriptions for students? I think you have to look at these things in terms of reality.

I would like to get into cost now. According to Bob Scanlon's paper, in 1968, for the six schools costs ranged from $31.18 to $236.08. I asked myself: what does the average district spend for instructional material -- textbooks, library books, etc? In 1968 I happened to do a national study and I found they had spent $20.66. That means to just teach your IPI program you would have to spend all of the money in the school district that is going for instructional supplies. I do not think you are going to get over those apples.

In 1973 you said your costs ranged from $20.16 to $216.45. In 1973 I did some figuring and found out that the average school district spent $29 per pupil for all instructional materials. I do not think you are going to stand much of a chance of implementing this one educational technological innovation when you are going to take 20/29 or 2/3 of the education budget just for the Math curriculum.

HUMAN, POLITICAL AND SOCIAL FACTORS

HUMAN, POLITICAL AND SOCIAL FACTORS IN THE USE OF EDUCATIONAL TECHNOLOGY TO IMPROVE SCHOOL PRODUCTIVITY -- SOME ISSUES AND RECOMMENDATIONS FOR EDUCATIONAL DECISION MAKERS

by

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INTRODUCTION

The purpose of this paper is to consider some of the human, political and social factors which may affect and/or be affected by the use of educational technology innovations to improve productivity of school systems. One of the main themes is that one must consider the use of educational technology innovations in the context of other, somewhat competitive attempts to change educational practice. Thus, though this Symposium mainly focuses on the **use** of educational technology innovations, this paper also considers ways in which such innovations are designed and developed, because these processes differ significantly from the preparation of other innovations -- innovations with which educators typically are more familiar.

This introductory section defines key terms, following which three sections delineate issues relevant to the use of educational technology innovations; the final two sections enumerate recommendations and comment on constructive use of such innovations. Throughout the paper, the general objective is to raise issues and to clarify problems which may arise in conjunction with use of educational technology so as to identify positive strategies for educational decision makers.

DEFINITIONS

Educational productivity is defined broadly and refers to optimal human and personal development in terms of widely ranging educational goals delineated by students and the community at large as well as by professional educators. **Educational technology** is defined in accordance with contemporary usage as "the systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and non-human resources to bring about more effective instruction (McMurrin, 1970, p. 5)." **Educational technology innovation** can refer to whatever means are considered necessary to attain delineated educational objectives, which may include interpersonal techniques and procedures (for students and/or teachers) as well as print materials, uni- and multimedia devices, computers and other electronic control equipment, etc. A key notion is that such methods and materials have been carefully prepared or selected as necessary educational components and that empirical data have validated that they facilitate the kinds of learning for which they were designed. Consistent with contemporary trends, **educational decision makers** include students, parents and other community members as well as professional educators.

Human, political and social factors relevant to educational technology could be considered from many different viewpoints and could cover a wide range of matters well beyond the space allocated here. Thus, it seems important to identify your author's viewpoint and main knowledge bases from which this paper was prepared. I view myself as a psychologist with interest in relationships between psychology's growing scientific fund of knowledge and applications to social matters, with special interest in educational and clinical applications. A forthcoming book (Snelbecker, in press), based on a review of several hundred papers and books, describes psychology learning research/theories and the various historical and contemporary attempts to relate this body of information to educational practice. Also considered in depth are recently emerging empirically-tested instructional theories and educational development (or, educational technology) processes. Much of my teaching and consulting time for over a decade has been invested in helping educators to be knowledgeable evaluators and users of educational technology innovations and of psychological information in various forms.

IMPROVING SCHOOL PRODUCTIVITY?

When contemplating ways in which educational technology could improve school productivity, it is very easy to focus exclusively on favorable attributes of educational technology innovations. But it is very important to recognize that educators and the general community may resort to other sources for improving educational practice, without noting any special advantage in research-based innovations. In various papers, Richard Schutz (Editor of the **Educational Researcher**) has suggested that we need "advertising" and "consumer education" concerning the advantages of educational development processes and other research-based means for improving educational practice. Glass (1971) has depicted research-based educational knowledge as an "elastic commodity" for which there are a number of "substitutes" and for which the consumer "demand" will decrease if the "price" is too high. He, too, calls for a continuing "advertising program" to help educators recognize advantages of research-based innovations. This leads us to two questions: What sources of information and suggestions are available to educators to improve school productivity? What alternative models may be considered by educators as means by which someone can synthesize (and validate?) such information, including but not limited to research findings, to make decisions about improving educational practice?

Possible Sources of Information and Suggestions

Following are some sources from which educators may derive information and suggestions about improving school productivity:

1) Folklore and personal (education) experiences

2) Anecdotes about some "similar" teacher, student, school, etc.

3) General philosophical viewpoint or position

4) Principles from an educational theory which is "established" (widely accepted) but not systematically submitted to empirical test

5) Principles from discipline-oriented social/behavioral science theory

6) Principles from an empirically-tested educational theory

7) Educational technology innovations (based on philosophical, practical and scientific information, demonstrably effective in reaching delineated educational goals).

In almost all practical situations, educational practice reflects many different sources. It seems widely acknowledged that most practices are based on the first two or first four sources (cf. Sizer, 1972). This may be due to the continuing controversies as to how we might use research findings (Gideonse, 1969), the fact that many different practices might be consistent with relevant basic theory (cf. Bolles, 1967; Boulding, 1956; Buhl, 1969; Milsum, 1966; Popper, 1957; Richter, 1972), and the fact that only comparatively recently have we fully recognized that "Innovation, by whatever theoretical derivation, involves vast development and engineering (Bruner, 1971, p. 101)." Such problems in using research findings are not unique to education; similar problems have been encountered in uses of social psychology theory (Meltzer, 1973; Varella, 1971), early childhood research findings (Chapman, 1972), industrial and military applications (Chapanis, 1967), and clinical psychology and psychiatric psychotherapy theories (Broskowski, 1971; Lanyon, 1971; Lanyon & Broskowski, 1969; Lazarus, 1971). Even empirically-tested educational theories may pose problems as to implications for specific practical situations, since they may involve quite general principles for a wide range of educational situations (cf. Gordon, 1968 & 1972). Since the seven sources are arranged in the order roughly in which they have emerged historically, it is not surprising that educators and the general community are most apt to be familiar with the first four sources than the others. Although the last three sources make use of scientific method to test assertions, only with the last source can we assume that the innovation has been modified until empirical evidence validates its utility. Given the topic of this paper, it is noteworthy that educators are **least** likely to be familiar with the last of the seven sources.

Models for Synthesizing (and Validating?) Information to Make Decisions

Following is a list of ways in which information drawn from various sources (such as the above seven) can be synthesized, and possibly validated, so as to make decisions about improving school productivity. Once a problem or goal to improve educational practice has been identified and one or more sources of suggestions has been delineated, how might one decide on action to be taken? Information syntheses might be done intuitively or through formal procedures; action might be taken after synthesis, or it might be delayed until the tentatively planned innovation had been submitted to some empirical test. We reserve "validation" for those instances in which formal empirical tests are conducted and modifications are made in the innovation until delineated objectives are attained.

1) An educator learns about an approach and tries it.

2) An educator learns about various possible suggestions, some of which contradict others; on an intuitive basis, a decision is made and applied.

3) In addition to intuitive synthesis, case study data are collected by the educator to evaluate the innovation.

4) With intuitive or formal synthesis and planning, the resulting innovation is formally evaluated and modifications are made until validated.

5) An educator adopts an educational technology innovation which was designed and validated for a relatively small portion of the educational experiences, such as a particular educational objective, a course, or a special learning experience. Information may or may not have been provided as to the innovation's relationships with the other educational experiences.

6) The school adopts an educational technology innovation which was designed and validated for a total program or major section, such as a total elementary school system, a complete special education program, etc. The innovation may be relatively unstructured, providing many options for students and teachers, or it may involve quite explicit directions to be followed strictly by educators and students.

Educational practice in any given school typically reflects various synthesizing and decision-making models, combining information from one or more of the seven possible sources enumerated earlier. The fact that one alleges use of "scientific findings and theory" does not automatically indicate which model is used, since such information could be used in all seven models.

Although comparatively little empirical evidence exists about educators' use of research findings (cf. Nelson, 1972) it seems well established that typically a "knowledge broker" is involved (cf. Glass, 1971). In brief, some middleman -- e.g., an educational psychologist -- **purveys** a rather wide range of research findings, principles and theories which allegedly are relevant to and, if "properly used," can improve school productivity. The "consumers" sample the commodities offered and, if they act "wisely," find **some way** to use this information (or selected portions of it) in their practical situations. With a knowledge broker approach, educators are more likely to use the first four models than the last two, although it is plausible that such middlemen could also purvey educational technology innovations. Such emphasis on educators' synthesizing functions -- in contrast with educational technology innovations, where the innovation developer assumes major responsibilities for synthesizing and evaluating information -- has been so widely accepted in education that many studies about innovation adoption have focused on administrative provisions (cf. Ross, 1958) or on overcoming the "resistance to change" supposedly encountered among some educators and other community members (cf. Havelock, 1973; Maguire, 1970). Possibly as a result of these general views, some developers apparently try to make their innovations "teacher-proof" and "student-proof," an attempt which has already resulted in negative reactions from some educators. But there is evidence that educational technology leaders recognize prospects and problems involved when someone outside the school (i.e., the innovation developer) accepts responsibility for synthesizing information and evaluative desirability of methods and materials (cf. Maguire, Temkin & Cummings, 1971; Temkin, 1970).

Some Observations About the Magnitude of Educational Change

To some, "improvement" almost automatically means that one discards **all** existing materials and techniques and selects one of several available theories or educational philosophies, resulting in massive changes. But this is not the only way by which one can foster change. Following Popper's (1957) thesis that social progress and social science may be more readily improved via a "piecemeal social engineering" approach rather than through new "Utopian" ventures, I would suggest that educational change can involve improvement rather than destruction of existing practices. Though I recognize that other Symposium participants advocate more radical modifications, I prefer "evolution" over "revolution" because "totally new" approaches typically bear at least some semblance to previous practice and usually have their share of problems to be resolved. One decision which must be made is whether educational technology innovations should be viewed as improving or replacing existing practice, or whether both approaches can be pursued.

RELEVANT CONTEMPORARY ISSUES AND TRENDS

In this section we will enumerate some issues being debated by educators and probable trends which seem especially relevant to the use of educational technology innovations. Our intent is not comprehensive coverage, only consideration of aspects relevant to our present topic.

Manpower and Training Needs

Three questions involve manpower and training needs: How does use of educational technology innovations affect current and future supply/demand involving teachers and other education personnel? What manpower and training changes are required to produce such innovations? What manpower and training changes are required for successful use of such innovations?

Obviously one must consider the number of persons available for traditional education jobs as well as the changes in staffing patterns which may result if certain innovations are adopted. Moreover, both development and adoption decisions may be affected by the current surplus of teachers. But it would seem inappropriate to make such decisions solely because of personnel considerations: Educational technology innovations should be developed and adopted mainly on the basis that they demonstrably facilitate learning.

Despite the current teacher surplus (with some exceptions, such as special education), it appears that we do not have adequately trained personnel to develop and to use educational technology innovations. Whereas many programs exist for training educational researchers and their strategies for conducting research have been devised, comparatively few programs provide training in educational development and there is controversy as to the best means for designing and developing innovations. A number of NIE-sponsored programs have been developing educational development self-instructional materials, but many of these are only at the field-test stage and there is some controversy as to their quality. But more relevant to our present topic, there are many problems to be resolved concerning helping educators to be knowledgeable evaluators and users of such innovations. In our earlier discussions we outlined alternative and somewhat competitive means by which educators might try to improve educational practice, and we noted that many educators are not sufficiently familiar with educational technology innovations that they recognize advantages in this approach. For example, they are not accustomed to asking for empirical evidence concerning an innovation's effectiveness when making adoption decisions. In addition, some innovations may involve extensive changes in activities in which teachers engage -- e.g., more guidance functions and serving as resource persons rather than information dispersers. Some innovations will involve more differentiated education positions than typically found in traditional one teacher per class arrangements. However, these educational technology innovations can vary greatly in character so that one must consider staffing patterns and training requirements with reference to specific innovations and adoption schools.

Accountability

Judging from professional journals and other literature, it seems quite likely that **accountability** (broadly defined) will continue as a focus of interest and debate in education. This could be viewed as part of the larger **consumer era** Zeitgeist: Throughout society, people are asking pressing questions as to what they are gaining for their expenditures of time and money.

Such concerns with accountability may foster more widespread acceptance of validated educational technology innovations and may cause greater interest in any innovations which identify educational goals and monitor students' progress toward them. But the "specific objectives" to which we referred in our (McMurrin, 1970) definition of educational technology can be expected to produce widely ranging opinions, with some educators and others contending that some educational experiences may not have any specifiable or measurable objectives which can be designated prior to the learning experience. Elsewhere (Snelbecker, in press) I have advocated broadening our conception of measurable objectives to include not only the "behavioral objectives" which have measurable increments ("results objectives") but also to include "process objectives" which seem especially important to humanistic psychology advocates and to discovery learning proponents.

But accountability has other implications for educational technology innovations. As we noted above, these innovations involve synthesis and evaluation of information, encouraging the impression that they permit less autonomy for the educator (and, possibly, for the students) than do other innovations. If performance ratings and job status for educators, following current trends, are based at least in part on students' learning, serious ethical, professional and legal questions may be posed with educational technology innovations. Can an educator be held fully accountable for students' learning if professional activity is set by highly structured innovations. If it can be shown that the teachers and students implemented the innovation in accordance with instructions (assuming some reasonable variation), perhaps the innovation and its developers may be charged with partial accountability.

Relevance, Students' Roles, and Individualized Instruction

Perhaps one of the most important contributions provided via educational technology innovations will be individualization of instruction to an extent not possible previously (except, perhaps, with very creative tutors). Even without hardware, these innovations arranged as modules can provide more flexible learning experiences than those in most traditional classrooms. With electronics communication technology and multimedia equipment, learning experiences can seem almost "tailor-made" for each student.

As a result of increased flexibility in choosing objectives, sequencing educational experiences and pacing instruction, the student can learn to be independent and to take responsibility for planning and carrying out learning experiences in ways not generally possible in group-paced instruction. Thus many contemporary concerns about "relevance" and "students' roles" have new meaning as the student and the teacher review assessments of progress and identify educational objectives and learning experiences.

Emergence of Instructional and Other Educational Theories?

It seems more than coincidence that the 1960's was a time of considerable progress for educational technology as well as for formulation of instructional and other educational theories. These empirically-tested educational theories serve both as an input to innovation development and as a result of such activities, since such applications help to test and to extend the theories. It would appear that the future fortunes of empirically-tested educational theory will be closely related to those of educational technology more generally, and will be directly influenced by policies and funding of NIE and USOE.

Two patterns concerning these educational theories are relevant to educational technology innovations: a trend toward more eclectic practical applications, and the view that research/development/practice are interdependent rather than linearly related.

Both Drucker (1972) and Shane (1973) have depicted previous competition among theories as somewhat artificial and have called for more eclectic use of positive features of various available theories. Similar patterns are also increasingly evident among proponents of various views; for example, Rogers has endorsed selective use of programmed instruction along with humanistic psychology programs, and some behavior modifiers are drawing ideas from a wide range of theories. It would seem very important that empirically sound and logically consistent theories be used for developing innovations, and that potential users should be provided with information as to the rationale underlying a given innovation so that they can assess its potential contributions to their general educational program.

Special Problems Concerning 'Hardware'

Most surveys reveal a curious mix of educators' reactions concerning electronic and multimedia hardware (cf. Carnegie Commission, 1972; McMurrin, 1970; Saettler, 1968; etc.). Most educators at best feel uncomfortable about using equipment, while a significant minority comment that they do not see how one could teach without these resources. One probably contributing factor is the tendency to teach "audio-visual devices" or "educational media" as courses separate from other education courses, so that many educators have not conceived integrating such hardware as part of overall educational planning. Moreover, too many educators have had unfortunate experiences with malfunctioning or poorly designed equipment, and administrators in particular are leery about extra costs for maintaining equipment. With regard to computers, we sometimes have the curious situation where public school students have had more opportunities to use them than have many educators (although the latter sometimes are required to use them in graduate research courses). Overall, educational technology innovations which involve equipment can be expected to pose a number of special problems at adoption consideration and during implementation.

But perhaps the greatest problem which can and must be solved is that we have rarely used equipment creatively in improving educational practice. It is almost as though we have been limited by our earlier two models for educational experiences -- the interpersonal processes in tutoring or in lecture-discussion situations, and the one-directional experiences provided through various kinds of print materials. As a result, even modern electronic control equipment and multimedia devices have essentially been limited to modified "canned" lectures or to "page-turning" types of learning experiences. Of course there are exceptions where various kinds of equipment have been used to provide new forms of learning experiences, but we have yet to utilize modern devices to provide new forms of learning experiences made possible through multimedia devices, electronics communication equipment, etc. Although costs obviously must be designated as one barrier for some developments, there is need for some national agency to stimulate and to support interactions among the various kinds of professional persons who could combine their efforts to create truly innovative uses of multimedia and electronic equipment.

Business, Government and Education

Both tutoring and lecturing involve educational operations which can be developed and managed quite readily by an individual or a small group of people. Print materials can be used in conjunction with tutoring and lecturing activities, but their usage typically requires collaboration of a much larger group of people. For example, there must be some rather widespread agreement about the contents of books in order to make it economically feasible to publish them.

But educational technology, with its emphasis on validated innovations and its greater use of educational media and electronics communication equipment, requires far greater collaboration and cooperation in pooling the time and money which is required to produce them. Consequently, we can expect that successful exploitation of educational technology's approach(es) to the improvement of school productivity will depend upon more constructive interactions among business, government and education professionals than have ever been expected or required before. Given the relatively few historical precedents for such interactions, it does not seem surprising in retrospect that many "human, political and social" problems emerged in conjunction with the various attempts to launch educational technology ventures in the 1960's. Even worse, many of these same problems have persisted so far in the 1970's.

Judging from my contacts with representatives in these three sectors -- business, government, education -- and the literature of their respective areas, there are many myths and misconceptions which each of these groups has about the others. Consequently, though all parties concerned seem to look forward with pleasure to the mutually beneficial effects which might be accrued through constructive collaboration, there is considerable apprehension among all parties concerned as to if and how such collaboration can be accomplished. At the risk of sounding overly critical, let us identify some of these present patterns.

Many business representatives seem almost bewildered at education's traditionally rather vague designation of objectives and its tendency to shift educational practices seemingly at times to keep in vogue with current issues, trends and preferred conceptions of educational practice. Moreover, in contrast with the identifiable purchase agents and decision processes typically found in some centralized fashion in industrial and military procurement procedures, the education business world involves highly diverse decision makers and processes, depending on the particular state, regional or local organizational patterns. Even the local character of direct consumer marketing is not as complex an activity as is required when business tries to market its equipment and materials to educators.

Compounding matters, when business representatives observe that many education purchase decisions apparently are **not** based on careful consideration of a given innovation's validation evidence, they raise serious questions as to whether educational development procedures constitute "frills" or "essential features" of a marketable innovation. Many seem to have concluded that only educational researchers and research psychologists are interested in knowing if and to what extent an innovation has been tested and found to be effective.

Businessmen also generally seem unclear as to what role government agencies (especially federal agencies) and public monies can have in developing educational innovations. This has special implications for developing educational technology innovations. Businessmen have seemed better able to understand the need for investing in systematic R&D to develop **hardware**, but they have not fully recognized the critical need for the even more expensive processes involved in **software** development. Perhaps the key remedy may lie in finding standard means whereby public funds can be used in development stages, somewhat as has been done for many years in developing military equipment and more recently in developing such civilian items as jet aircraft. Although some educational R&D agencies already participate in such collaborative activities, on the basis of my information, most businessmen, educators and psychologists seem unclear about such possibilities.

Educators seem to view collaboration with businessmen with sharply mixed expectations and emotions. There is a widespread belief -- almost fear -- that business may have such overwhelming influence that it will take control of educational activities out of the hands of professional educators. They particularly express concern about the possibilities that the profit motive will exert undue influence. In conjunction with this, many researchers and educational developers hold the belief that if an innovation is properly developed and validated it will be readily adopted. In a sense, many seem to view **marketing** to be a "necessary evil" which one must accept if one gets involved with business. They do not fully realize the positive contributions which can accrue from ethical and competent marketing, nor do they adequately recognize that innovations will **not** necessarily be adopted merely because validation data document their capabilities.

Government views (especially at the national level) have always been rather difficult to characterize, since **change** in organizational structure and in announced objectives seems to be almost endless. But one can say that most agencies and sections which have some concern with utilization of research findings and technological developments in the improvement of education tend to rely on the "knowledge broker" model. There even seems to be some distinction between those sections which are concerned with monitoring functions of and disbursing funds to existing school systems vs. those sections which, in one way or another, focus on research/technology applications. Of course in many ways this mirrors the characteristics and problems of the school systems. As a result, several problems persist. We do not have adequate means and strategies for organizing information relevant to practical problems, since many findings are discipline or theoretical-problem oriented. We need some resolution, for example, as to feasibility and desirability of developing "engineering" handbooks, instructional (and other educational) theories, practical problem oriented state-of-the-art papers, etc. We need an articulation of "standards of the industry" for educational technology innovations, somewhat like those which were developed in the 1960's for programmed instruction and which have been developed and modified for psychological and educational tests on several occasions during the past several decades. We need dissemination of information concerning use of public monies for fostering constructive collaboration of education and business in the development, marketing, installation and maintenance support for educational technology innovations. And of most direct relevance for our present topic, some "consumer education and information" mechanism(s) must be devised.

One should qualify the above critical comments by noting that many people recognize these problems and that various individuals and groups have attempted to cope with them. For example, various business consultants and related publications (e.g., Educational Technology, 1973; Hope, 1971 & 1972) not only provide prospective marketing information, but also advise their clients of ways by which they may cope with such matters. Various educators, psychologists and other professional persons -- and their respective organizations -- have launched projects which have dealt with one or more of such issues. Various governmental groups have worked on one or more of these problems. But it is my conclusion that progress on these matters will only occur to any meaningful extent when some federal agency identifies its mission as the whole spectrum of educational technology development and utilization.

USING EDUCATIONAL TECHNOLOGY INNOVATIONS

In this section we will consider the above issues as they more directly relate to successful use of educational technology innovations. Instead of repeating above observations we will state brief comments or questions which relate particularly to consumer education and information and to the various persons involved, including administrators, teachers, students and the community at large.

Consumer Education and Information

Educators and the general public need consumer education and information about educational technology. If these innovations are to be used in such a manner that school productivity (in its broadest meaning) is improved, responsible persons need assistance in knowing that they exist, how they compare, how they relate to other educational practices and how they can successfully be used.

The kinds of consumer education and information which will be required will depend in part on the circumstances upon which the innovation is being considered and on the nature of the innovation. For example, there are different implications when an educator is approached or asks to try a specific educational technology innovation vs. when an educator has no pre-selected innovation but has recognized some need for improving educational practice. Should available innovations be announced in some form of "catalog?" Should evaluative information be provided by the developers and/or by some third party? Should availability information be listed in a general catalog or by subject matter, age group, special education needs, etc.? Should information be provided concerning undesirable "side effects" (such as "facilitates learning but may foster negative attitudes toward teacher," "develops constructive views about self but does not provide much substantive knowledge about scholarly work on this topic," etc.) or even contraindications to usage? What kinds of documentation should be expected? Is it sufficient to provide summative evaluation data summaries, or should the consumer be able to review formative evaluation data and the knowledge bases (practical and scientific information, etc.) from which the rationale for the innovation was derived? What help would be provided to consumer-educators to distinguish among innovations and to decide which innovation(s) should be selected for their schools?

We also need resolution of questions concerning the kinds of information and support which should be provided to educators during demonstration uses of an innovation and during more widespread usage. Authorities seem to differ as to where the development process should stop and the more commercially-oriented marketing activities begin. There may even need to be some overlap in these processes. This would have both administrative and funding implications, since it may mean combined uses of public monies and private enterprise investments. In addition, it may quite likely mean that there should be some kind of "buyer's manual" which should accompany an innovation.

It has been a common experience that one of the major reasons for innovations' "failures" is that they were not properly used. Typically, some student or teacher may not have followed certain instructions because they did not seem especially important. For example, some disregarded programmed instruction directions that correct answers should be examined only after the student's response was formulated, and others even disregarded the special sequences which were to be followed in certain programmed texts. While some learning could be expected even under these variations in usage, the important point is that "failures to learn" conceivably could stem from "failures to implement" the particular innovation. Consumer-educators and students need some guidelines as to probable causes and corrective actions when various kinds of problems are encountered. Though general "trouble shooting" strategies have been formulated (cf. Snelbecker, in press), it would be most helpful if information concerning a given innovation would be included in the descriptions and instructions about using that innovation. What form this information should take remains unresolved.

Some concerted effort is needed as to ways in which educational technology innovations may relate to other aspects of the school's existing practice. Of course, there will be instances in which the innovation consists of a **total** school program -- such as is now found with some adoptions of the "open classroom" approach of "the behavior modification" approach. But it seems likely that there will be many more cases in which various kinds of innovations will be found in the same school or in the same classroom. In some situations, students may have the option of selecting alternative educational experiences. In cases where various innovations are used, successful utilization of a given educational technology innovation will depend to some great extent on how much guidance and support is given to administrators, teachers and students in integrating the innovation(s) with the total school experiences. Current literature and authoritative observations suggest that we do not yet know all dimensions of the problems involved, nor the range of viable alternative solutions to these problems. However, it is noteworthy that a considerable fund of information and strategies have been evolved by various educational R&D agencies, including as an example the Administering for Change Program at Research for Better Schools, Inc. Perhaps with the guidance and support of a major federal agency, the fruits of these various national efforts could be reviewed and relevant information provided to respective personnel involved in utilizing educational technology innovations.

Some Questions and Concerns Relevant to the People Who Use Innovations

In a sense, despite the laudatory efforts of all who conceived and developed an educational technology innovation (or any other innovation), inevitably the innovation is really defined by the ways it is actually used in schools. Many people are involved in using an innovation -- administrators, coordinators, teachers, teacher-aides, students, and (indirectly as well as directly) the community more generally. Although I have tried to keep these people in mind while discussing earlier matters, there are a few observations to be made more explicitly from the viewpoint of those who may use an innovation.

School activities have their rewarding moments, but many are the times in which all parties concerned are very busy doing the mundane tasks of simply getting through one more school day in a manner which will be at least minimally consistent with that community's expectations for schools. In this context, an educational technology innovation may seem like something with which universities or model schools might become involved but something which "more ordinary" schools might not have time to explore, given their already crowded schedules. If educational technology is going to have more than "show-and-tell" value, viable means must be evolved so that we do not simply get engrossed in the process of providing innovations which disappear after a few demonstration projects. Hopefully, great strides have been taken through the regional educational laboratory networks of schools scattered throughout the country. But it remains to be seen whether we have devised strategies for facilitating use of educational technology innovations (not only a few, but the very many which most likely will be developed) on a wide-scale basis in schools all over the country.

Many educators, students and the community more generally are more likely to respond to the hardware aspects than software aspects of educational technology. In this narrower meaning, as well as the broader meaning of educational technology, it is generally acknowledged that strong feelings are aroused among both proponents and critics. Of particular concern are ways in which such innovations might influence the status of persons who use them: Will teachers lose their jobs? Must administrators devise more complicated job descriptions for an expanded description of teaching and support personnel? Will new kinds of professional positions be created? What changes will be made in students' roles, and will these changes involve modification of ways in which educational experiences have been viewed in the past? What kinds of costs will be involved (money, time, feelings and other psychological aspects)? Will there be identifiable gains in effectiveness, efficiency, diversity, etc.? What implications are there for administrative practices, particularly if we reach a point where within the same school or same classroom several alternative approaches to instruction are available to students? Will it be necessary or advisable to change group purchasing practices? If so, how might school expenses be influenced? How will allegedly externally validated educational systems influence current views and practices about educators' accountability? Will a focus on having students attaining educational **objectives** require changes in administrative practices? Will personnel need special in-service training to use given innovations? If so, will the adoption of the innovation result in time savings during which such training can be provided, or is this one more hidden cost in these innovations? From the vantage point of parents and other community members, does the adoption of an innovation mean that local educators have relinquished their control over school programs? Would such contemplated changes, arising in conjunction with the innovation, mean that the community's general school objectives are being attained, that they may be changed, or what? Many feel that proper use of innovations depends mainly on the educators and students most directly involved; what affect, if any, might this have on the people involved? Will there be changes made in scheduling the daily activities and in defining a "school year"?

RECOMMENDATIONS AND DEMONSTRATIONS

The purpose of the foregoing discussion was to identify issues, problems and barriers which should be considered for successful use of educational technology innovations to improve school productivity. Of primary concern are those human, political and social factors which affect or are affected by such innovations. Some of the following suggestions are relevant to specific demonstrations, while others hopefully will help to create a general climate which fosters successful use of educational innovations.

1) My first recommendation is that any demonstration project should include those kinds of consumer education/information details which are pertinent to the project especially as they answer questions raised in the above section of **Consumer Education and Information.**

2) Demonstration projects should include print descriptions and resource person support to answer questions such as those listed in the previous section, **Some Questions and Concerns Relevant to the People Who Use Innovations.**

3) A task force or project should be initiated (if none already exists) to generate criteria for assessing and evaluating educational technology innovations. These guidelines should be formulated in language intelligible to consumer-educators and interested non-professionals (i.e., other community members) and should be made available to potential users of such innovations. Selected demonstration projects should be used to provide empirical data concerning what kinds of information are necessary.

4) Developers should be encouraged to provide suggestions for detecting inappropriate uses of innovations and recommended corrective steps to be taken. The effectiveness of these guidelines should be assessed in demonstration projects. Independent measures should also be obtained during demonstration projects to develop means for examining students' and teachers' activities so as to devise monitoring systems which could be used by regular school personnel during wide-spread adoption of the innovation.

5) Some federal agency or section should actively encourage formulation and testing of instructional theories to facilitate development of educational innovations and to enable users to understand the rationale underlying a given innovation.

6) Various federal and other agencies support and otherwise encourage social/behavioral science research. But there does not seem to be any federal group which supports and coordinates systematic **synthesis** of research findings and theory in forms which are useful for **practical** situations. As a result, there are many questions concerning the form that such information should take, given the present status of social/behavioral science theory and educational research findings and theory. Some would propose "engineering" types of data handbooks, others favor state-of-the-art papers on relevant information, others contend that we mainly need concerted efforts to formulate empirically-tested educational theories. It is recommended that some federal agency accept the responsibility for exploring the various means by which such information could be organized, the steps needed to facilitate such syntheses, and the nature of communications which might be addressed to innovation **users** as well as producers.

7) As one reviews the activities of various federal agencies, many can be identified which engaged in educational technology activities in one form or another. Given a similar situation of rather scattered activities concerning research on early childhood development and research on adolescence, formal interagency panels (one for early childhood, one for adolescence) were convened to formalize cooperation among the respective agencies. It is recommended that a similar interagency panel be convened on **educational technology.** Their communications could be extremely valuable not only to producers of innovations but also to users, since users frequently are not as familiar with relevant federal agencies so that they know where they can find information about educational technology.

8) Assistance is needed by both innovation producers and users to determine what changes, if any, will result in school staffing patterns and job responsibilities when educational technology innovations are used. More information is also required concerning the kinds of pre-service and in-service training which should be provided. Of course, specific questions can not be answered without considering the nature of the particular innovation (e.g., how comprehensive, equipment operation needs, interpersonal technique requirements, relationship with other school programs, etc.). However, there certainly will be many ways in which otherwise rather unique innovations will involve training needs comparable to those of other innovations. It is recommended that some federal agency cull the literature and contact relevant project personnel and school personnel to determine the state-of-the-art on this matter, and that the same agency serve as a communications center for both producers and users of innovations when training questions arise. Perhaps this same agency would be in a position to clarify questions about manpower needs and formal university and other training program projections, a matter on which one can find highly diverse views today. This additional information would also be useful to superintendents and other administrators as they relate to selecting and using educational technology innovations.

A FINAL OBSERVATION ABOUT HUMAN, POLITICAL AND SOCIAL FACTORS

One of the key ideas in the development of educational technology innovations is that they are planned and developed with respect to specifiable educational objectives. It is recognized that some persons may express concern about reliance on an approach to education which places such great emphasis on **outcomes.** Most of you are familiar with the controversies which started in the late 1960's concerning "accountability" in education. In some instances, educational objectives were so narrowly defined that they omitted many of the educational experiences which are considered important to society generally, partly on the basis that some educational objectives are difficult to measure. Criticisms were also raised because some educators were "teaching to the test" instead of trying to provide broadly ranging educational experiences. Finally, others were concerned because the concept of accountability had led some projects to emphasize **minimal** educational objectives without taking into account the widely ranging ways in which students might differ in achieving their individual human potential.

With regard to such concerns, I would contend that constructive use of educational technology, including electronic communications devices and other kinds of equipment as well as the strategies of having innovation modifications based on the extent to which educational objectives are being attained, can facilitate educational improvement by building onto the good features of existing practice **or** by creating new systems. I would concur with the observations of a noted educator who played several key roles in the formation of educational research and development agencies. Dr. Francis S. Chase served in various capacities, including chairing the National Advisory Commission for Regional Educational Laboratories during the first critical years of their development. Commenting on directions where educational research and development ventures might lead us "in the remodeling of education," he subsequently (Chase, 1970) depicted them as providing means for **continuous** improvement of education by combining old and new ideas. Although he acknowledged that initial ventures might focus on mastering minimal level skills and knowledge, he expressed the hope and expectation that individual characteristics and creativity could also be fostered as well.

> "The early emphasis quite properly is on helping all members of society acquire the skills and knowledge essential to effective participation in the opportunities, responsibilities, and benefits of our society; but I anticipate, as we learn how to provide facilitative learning environments, and to manage an array of complementary educational arrangements, attention will shift to the development of human capabilities that lie beyond the skills required for effectiveness and lead into the domains of creativity, spontaneous enjoyment and cultivated sensitivity to values (Chase, 1970, p. 304)."

Perhaps one of the most important **human, political and social factors** to be considered in our contemplated **uses and development** of educational technology innovations will be the extent to which we attain minimal objectives **vs.** the extent to which we can use educational technology innovations to foster actualization of human potential in creative and diverse forms.

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DISCUSSANTS' REMARKS

Representing American Federation of Teachers -

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Roslyn, Pennsylvania

Representing Administrators -

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JAMES GARBERINA'S REMARKS

tive In reacting to this paper, I would like to consider the elements of the paper from my perspective as a teacher and as an officer of the Philadelphia Federation of Teachers. I readily admit that the reading of these symposium papers and other outside readings have made me a little more knowledgeable with the symposium's topic. They have also given me insight into both the educational technologies and philosophies of some of the experts in the field. I disagree with some of them and, of course, I do agree with others.

Dr. Snelbecker's paper reflects, for the most part, the type of understanding with which I think I can agree.

His paper points out that there is a need for advertising and consumer education so that the teacher is aware of educational technology innovations. It is only after the teacher becomes aware of the innovations, which he sees as practicable and useful, that he will attempt to get an administrator to consider the innovation and its purchase.

For example, the principal in my school was a Science specialist. When he was assigned to the school last year, he brought with him a whole wealth of ideas and knowledge in that field. But, innovations presented to him by a knowledge broker, as Dr. Snelbecker calls him, in other fields may or may not fit in with other programs in the school. For example, Reading teachers should determine what innovations would be useful in those situations. There are four teachers of Reading at 7th and 8th grade levels at Rush Middle School. Another teacher and I have to use the programmed Reading kits, and what I call a semi-programmed literature kit in developing a course of study for the year. Two other teachers use different approaches.

The principal has to depend on the knowledge of these teachers when acquiring educational innovations in Reading for the classroom situations for the 7th and 8th grade students at Rush. For an administrator to attempt to initiate a program within the school involving innovations, with no formal and/or informal consultations with the affected teachers, would just be foolhardy. The teachers involved should, at least, either indicate approval of the innovation or a willingness to try it. Before the innovation becomes a permanent part of the school program, there should be a complete evaluation of the program, measuring both the cognitive outcomes and the affective domain of the students. The attitudes and beliefs of the teachers involved should also be considered in the evaluation. For example, is this a program they can live with year after year? If not, is there a possibility at this time that not even favorable measurable results will be reflected if the program continues?

Certainly, in the initiation of any educational innovation, the teacher must be the center of any consultation regarding the possible long-range success of the program in his classroom.

Dr. Snelbecker in his definition of EDUCATIONAL TECHNOLOGY INNOVATION states: "A key notion is that such methods and materials have been carefully prepared or selected because they are necessary educational components and that they have been tested and revised until they facilitate the kinds of learning for which they were designed." This concept is certainly true. However, I think it can be carried one step further. The innovation may have to be discarded if it does not fit into the particular classroom situation.

I would like to discuss for a moment, before I get into the AFT's approach and contractual relationships, the evolution-over-revolution that Glenn mentions in the paper. Certainly the Federation would find no disagreement with the evolution- over-revolution approach in educational change. Innovations are often foisted upon teachers as programs with high potential for success. Boards of Education and administrations are sold a bill of goods regarding a particular innovation and they spend a great deal of money on it before it has been tried out. The teacher is rarely involved, at least in my experience, in the initial contacts. The teacher becomes aware of the innovation after the program has been bought. Little, if any, pre-service training is involved, making perhaps a potentially worthwhile program worthless.

A number of years ago, most elementary school teachers became aware of the fact that New Math was going to be taught in the school one week before the school term started. They read it in the papers, in the Sunday **Inquirer**. Teachers returning to school found guides and books dealing with the New Math which contained concepts completely foreign to them. There were different reactions in different schools, but in one school the teachers were told there would be an in-service course for them to explain the new program and their in-service teacher was a trainee, who had a crash course during the summer months. This person knew very little about any of the concepts involved. As a matter of fact, two of the younger teachers in the school who had had New Math courses in college actually did the teaching.

In the elementary school in which I taught, the principal, though informing the teachers that the books and guides were available, left it to the discretion of the teacher whether the old or New Math would be taught.

The failure to provide adequate pre-service and in-service training and the failure to validate the innovation in the field for Philadelphia students before initiating the program city wide were probably some of the reasons for the reluctant attitude of teachers towards the program. New Math seems to be having its problems now and there seems to be a trend away from the program, and I think one of the reasons is that this validation did not take place.

I would like to talk about the relationship of innovations to contractual agreements for a minute. In Glenn's paper there are some questions raised about ways in which innovations might influence the status of the persons using them, and there are two questions which I feel should be added. Number one, have the teachers involved in the use of the innovations been contacted for initial input? And are they being continuously involved with developing plans? Secondly, what is the relationship of the innovation and its implications to the present teacher contractual agreement in that district?

To attempt to initiate a program which conflicts with the contractual agreement between the School Board and the teachers' union is both foolhardly and wasteful. It is pointed out in another paper in this symposium that the failure of an innovative program occurred because of a basic conflict between the program and the teachers' agreement in that school district. Involvement of the teachers' representative with the administration and other interested parties before the introduction of the innovation might have avoided the conflict. Many agreements contain clauses which enable changes if both parties are in agreement. Such a clause is contained in the Philadelphia agreement. Article I of the Philadelphia agreement reads in part:

> "It is also recognized by the parties that all provisions of this agreement may during its life be altered only by agreement of the parties."

Having personally participated in alterations of the agreement at the request of the administration in Philadelphia, I can vouch for the flexibility that this clause can give to participants who have a trusting relationship with each other.

There is also mention of pupil/teacher ratio. To the classroom teacher the importance of maintaining the pupil/teacher ratio is paramount. The first phase of the 1972-1973 school strike in Philadelphia received overwhelming support from the teachers primarily over this issue. The teachers in Philadelphia, at the end of September, were willing to return to school under the old contractual agreement, with no increase in salary. They even accepted a contract ultimately which gave them no increase in pay for over a month after they returned to school in February. However, they would not tolerate the increase in class size that the Board unilaterally required in September of last year. The Board's unilateral action had the effect of raising the maximum class size from 35 to 42 and up.

When the teachers went back in September, in my school as in all the schools across the city, they found 42 children in their classrooms, and some as high as 50, then, there was no way of stopping a strike in Philadelphia last September.

For any person involved in education to ignore contractual arrangements on class size in introducing educational innovations is to ring the death knell for that program. The teachers involved will not tolerate it and the teachers' representatives will not tolerate it.

However, even in this overwhelmingly important area, the teachers did accept maximum clauses, clauses in the contract which allow for class size maximums over the contractual agreement in the following cases:

1) when there was no space available,

2) when observing state maximum would require placing classes on a short time schedule, and

3) when a larger class size is necessary and desirable for specialized or experimental instruction.

Furthermore, the limitation of class size set forth does not apply to library, music, assembly or forum-type classes. So there is flexibility built into contractual agreements that will allow for use of educational innovations. Consideration of the contract with the teachers' representatives is essential if conflicts are to be avoided.

Regarding the necessity of educational innovations, the Philadelphia Federation of Teachers has taken a position on equal educational opportunity for students. This document, which has been submitted for action by the AFT national convention, spells out what the Federation means by equal educational opportunity, regarding age levels, intellectual attainment, social orientation and character development. In the specific items mentioned in intellectual attainment are two relevant to technology and to other innovations:

1) Provides him (the student) with appropriate and sufficient instruction to advance him as far in his physical, mental, emotional and spiritual development as he has the capacity and desire to go in response to optimum methods of motivation, instruction and educational experience.

2) Gives him, to advance his intellectual development, the tools which are available to any other student in our society.

Certainly educational technology innovations would contribute towards the realization of these objectives and they must be considered as necessary for the pursuit of equal educational opportunity.

I know I am getting close to running out of time, and I would just like to consider accountability. Glenn has directed several pages of his presentation to the area of accountability. First, I would like to point out that most school systems have developed procedures for handling teachers who fail to perform their teaching functions satisfactorily. Philadelphia has such a procedure, and each year there are teachers, including tenured teachers, who are dropped because they fail to perform their teaching duties. The Philadelphia Federation of Teachers, along with any other teacher union or organization, will guarantee to teachers that due process is followed in all cases.

However, it seems that the concept of accountability seems to go beyond satisfactory and/or unsatisfactory performance. It would seem to take into account, as Glenn points out, educational experiences which may not have any specific or measurable objectives which can be designated prior to the learning experience. The Federation has not taken any position for or against this broad concept of accountability. Each local has dealt with it as the implementation of an accountability plan takes place in its district. However, the problem of attempting to establish measurable objectives to make teachers accountable seems to be insurmountable.

Robert Bhaerman, who is the AFT Director of Educational Research, in discussing the attempts of state legislators to write laws on accountability stated:

> "State legislators must not reflect in their accountability laws a single philosophy of education. Instead, what they should reflect are teachers whose objectives are teaching for the increased

commitment and involvement of their students -- and not only those who teach for the mastery of factual information. I maintain that accountability laws be written -- if they must be written at all -- to reflect those teachers whose objective is to arouse personal response in students, whose goal is to awaken students to responsibility, and whose subject matter approaches include art, ethics and moral philosophy. These are some of the things state legislators will never be able to put into their legalistic measuring cups, and the sooner that lesson is learned the better."

The AFT's Consortium, a symposium in which there were more than a dozen workshops, touched many of the key issues enveloping education today. Accountability was a prominent item. Teachers from Florida, Michigan, Colorado, New York, Duluth, and other areas discussed accountability in their sections of the country. I would like to report to you some of the summaries from the symposium regarding California's Stull Act and New York's accountability plan, as reported in THE AMERICAN TEACHER, to show you the two extremes in establishing an accountability plan as far as the reaction of the teachers is concerned.

First the Stull Act, and here is the summary written in THE AMERICAN TEACHER:

" 'One year after passage of California's accountability laws there has been no identifiable impact on the quality of classroom instruction,' said Raoul Teilhut, President of the California Federation of Teachers. 'Further, there is no identifiable modification or improvement of the curriculum that existed prior to this law. The Stull Act orders school districts to set up performance objectives for teachers, against which they can be measured. It is supposed to make teachers accountable by forcing them to attain present goals, and, in the back of its writers' minds, will thus make it easier to dismiss incompetents.' "

"According to Teilhut, however, many school districts have not begun to consider implementation plans and those districts which have, have squandered tens of thousands of teacher hours and dollars drafting specific and general performance objectives that are little more than what the district curriculum mandated prior to the implementation."

"Teacher dismissals are down and Teilhut suggests that that is because of the evaluation paper work that Stull requires."

"One effect of the Stull Act: since September, 4,000 more teachers have joined the AFT in California, many of them probably as a result of the new state affiliate's support of Stull."

I will now summarize New York's accountability plan, which seems to be working much better than that plan:

"The accountability plan in New York City was developed by a joint committee whose members have been drawn from the United Federation of Teachers Local Two, the Administrators' Association, the Central Board of Education, parent groups, and the staff of the Education Department of the City University of New York."

"Describing the plan to the symposium participants, Abe Levin, UFT Vice President, stressed that it has been designed as an experimental five-year program to be field-tested in a limited number of schools. The first two years would see the program's implementation; the middle two would be devoted to corrective action; and, the fifth year to a system-wide evaluation by the formulation committee."

"The program, reported Levin, has two objectives: to find out what in-school factors determine effective student learning, and to find out what actual techniques worked with the general school population. The program's major thrust is to obtain massive data in order to develop corrective procedures which will not judge any particular teacher, but will act as prescriptive procedures."

"The approach and design of the program is expected to guarantee individual teacher safety because it will be aimed at a wide number of schools as a whole, rather than individual classrooms. The focus of responsibility has been shifted off the teacher and onto the program. The study will encompass questions of pupil mobility, average class size, state of plant and supplies, teacher experiences, turnover of student and teacher population, and administrative practices. Schools operating under both similar and diverse circumstances will be compared in order to isolate the affective factor present."

Philadelphia has a clause in its contract on accountability similar to New York. What type of program the accountability committee in Philadelphia will develop is something I cannot predict. Hopefully, it will follow New York's example and not lead us down the dead-end street that the Stull Act has apparently created for the teachers in California.

In the AFT Officers Report to the American Federation of Teachers' convention, President Dave Selden points out what he has done during the course of this past school year. He notes that he was involved in three major efforts in connection with agencies of the Executive Branch of the Government. Two of them would not concern you, but the second one he mentions is the Teacher Centers Project. This is a project of the Office of Education to study and make recommendations about forming Teacher Centers as a means of involving teachers more directly in educational reform and in the improvement of teaching techniques.

"My participation," he says, "helped give the report a pro-teacher slant. As a result of this involvement three other AFT members were added to the project." The report has been prepared and will be available in the fall.

ORLANDO F. FURNO'S REMARKS

I have been familiar with quite a bit of educational change through the work of Mort, and so forth. This paper was really dealing with human, political and social factors. I do not know whether Paul Mort developed that many enemies that people will not refer to him any more or whether history has passed all of his work by, but he did do a great deal of work in how educational practices were adopted and I think it would be worthwhile for people in educational technology to review the work of Mort and his students.

I happened to pick up a little piece of information in 1960-1961 regarding an adaptation called "Cumulative Records" and another adaptation called "Driver Education," and it is very interesting that it took some 55 years for most of the school systems in the United States to utilize Cumulative Records, but it only took about 20 years to put Driver Education into the curriculum. I think a little study like this might be very helpful, that is, to just take some simple educational technological innovations and see when they were first introduced into the school systems and how they are spreading throughout schools in the country.

With respect to manpower and training, Glenn made the statement that educational technological innovations should be accepted or rejected on the basis of whether or not they facilitate learning. That might be okay in theory, but in practice they are not necessarily accepted on the basis of whether or not they facilitate learning. I would like to illustrate with a situation in which we found ourselves. This is a true situation.

When we were negotiating across the table this January the union representative said to us, "Why aren't you guys paying our teachers bi-weekly rather than monthly? Don't you know that on their salaries they're practically starving before their check comes every month?"

I felt very sorry and I said, "We can't do anything right now about it, but I can promise you that we'll make that one of our high priorities."

We went ahead and hired a special computer programmer to convert out programs to bi-weekly, and we proceeded to devise a system. We indicated to the people in the school system that we were going to pay bi-weekly, and now I am talking about only a couple of weeks ago. In response comes this letter from the President of the Teachers Union: "We don't want you to do this."

This sort of stopped me. We had done a heck of a lot of work on this. I asked why.

"It isn't in the contract."

I said, "But you guys gave us holy hell in January saying you wanted your teachers paid bi-weekly."

"Yes, but you didn't negotiate it in the contract."

I said, "But isn't this a benefit to your teachers?"

"Yes, but if you fellows violate the contract with this item, God knows how you'll violate the contract with the other items."

Consequently here we are with a bi-weekly payroll that we can not implement. This indicates that you do not necessarily implement an innovation or put into a school system a technological innovation because it facilitates learning or benefits people. There is a lot more to this complex world.

Now on accountability. I think accountability is a very important factor and it is going to be very difficult to incorporate. I would like to state again for the benefit of the union representative that we are in agreement. We do not really want to implement the accountability, but legislatures enact it and we have to implement it.

To me, this has great implications for educational technology. For example, accountability and how it is set up will affect our teacher/administrator working relationships. It will affect the development of achievement tests, particularly since our law says we have to implement this year in the areas of Math, Reading and Spelling. How we are going to do this, I do not know yet.

We also have to process this information. We just can not collect it. We have 20,000 students and I suppose we have to have a pre- and posttest of some sort, and this involves a great deal of work. I doubt that we can do this by hand and analyze the results. Probably we will get into the development of optical-scan test documents and process them on the computer. You can see right away that accountability is going to increase our costs.

If we tie this in with responsibility, which means promotions, pay increments, merit pay, and job security, you can see the problems that we are going to have with negotiations throughout the districts in the United States.

I find it very hard when you examine the statistics in this area to hold the teacher responsible for student performance. When you take a system like Baltimore City, which a couple of years ago had about 40,000 youngsters absent 140 days or more, how are you going to hold teachers accountable for that?

In some instances, in many classrooms with mobility, even if kids were not absent, some teachers may have only five of the same kids in May as they had in September. How are you going to hold teachers responsible for this?

You might say let us hold the principals responsible for teacher performance. Some principals have faculties with a great turnover, and here again that creates quite a few problems in terms of how you are going to hold people accountable for performance.

Interestingly, Glenn drew reference to a federal Follow-Through project. We had a program financed by the Ford Foundation. When President Johnson kicked off his Title I program he mentioned it. Out of this early school admissions program grew the need to modify the kindergarten program, the grade one program, and the grade two program.

It was very interesting. We found that from the pressures of the project directors, some of the project professors, and possibly from the Federal government, that the results, of course, were very significant. But when some of the teachers talked to you, and indicated that they were teaching the test, you wondered how significant the results were.

Now, you had some special problems concerning hardware, and I think you raised some interesting points such as poor performance records of simple devices such as TV sets, movie projectors, etc. In fact, in one TV experiment in programmed instruction, one of the reasons it failed was that somebody kept stealing the TV sets.

There has been talk about vandalism. I have done a little study and found out that there has been some $150 million spent on overcoming the effects of vandalism. I think that would be enough to help you finance some of your educational technological innovations if you could devise methods for cutting down on these vandalistic acts. I am not talking about security guards. In some cities, for example, Baltimore City and I do not think Philadelphia and New York are any exceptions, funds for security guards went from maybe a few thousand dollars to over a million dollars. At least that was the situation in Baltimore City and, I think, it is the situation in communities such as Philadelphia, New York, etc. Here is a place you can find some of that money for which you were looking.

ECONOMIC FACTORS

ON MAKING DECISIONS ABOUT TECHNOLOGY IN ELEMENTARY AND SECONDARY SCHOOLS

by

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This paper is written about the use of educational technology in the existing educational establishment, specifically in school districts as they are now generally constituted. This limitation is introduced partly to allow some depth in the analysis and partly to concentrate on formal schooling rather than trying to include mass communications.

Throughout this paper "technology" will mean some change in or addition to methods of teaching which involves a form of hardware with its associated software. Teaching teachers a new method of presenting material, rewriting a textbook or reorganizing the grade structure are not, therefore, technological changes for the purposes of this paper (although many of the comments would apply to such changes). If studies of educational technology are to be distinguished from studies about educational improvement in general, then the existence of some form of hardware must be postulated.

The analysis concentrates on technology to aid in teaching, not on the teaching of technology.

The last assumption is that our time horizon is about 20 years, not 100 and not two or three. We are dealing with long-range planning but not "futurism."

HOW TECHNOLOGY IS USED IN BASIC EDUCATION

There are three ways in which a technological innovation can be used: 1) as a small tool for improving the existing teaching-learning processes, 2) as a tool which requires a prior capital investment, and 3) as a replacement for the existing teaching process in an existing or completely new school.

The level and nature of the decisions, and, therefore, the cost-benefit analysis required in each of these three situations is different and they will be examined in the succeeding three sections of this paper. When the technological innovation serves as a tool, the decision to use it and the extent of this use must be up to the teacher. It becomes a tool very much in the way that a paint brush is a tool of a painter. The choice of the nature and quality of the brush is integral with the way in which the artist works (and since teaching is indeed an art this analogy should hold). To make a separate cost-benefit analysis on an individual tool is nearly impossible. The way in which the tool is used contributes so significantly to its ultimate benefit that the tool itself cannot be considered as a separate item. Also, where the process is artistic the benefits, both from the overall process, or, specifically, from the use of a new tool, are very difficult to measure.

Case two has added complexity. In this case, the individual teacher cannot utilize the tool at will because a prior capital investment is required. A significant portion of the teachers in a locality must be willing to use the tool in order to justify, even on an intuitive basis, the investment.

The third situation is, in principle, a straight-forward capital investment problem. We evaluate alternatives, some of which may involve technology, on the basis of their present-discounted-value, looking at the cost and benefits in future years. The difficulty in education, of course, is that it is almost impossible to pin-down the benefits.

Let us look more deeply at each of these ways of using technology.

Cost/Benefits of Educational Technology When Used as a Personal Tool

Technology such as audio-visual aids, filmstrips, movies, cassettes or even television (ITV) are tools. The question is what tools and aids does the teacher choose to use (Knezevich, p. 87). It is true that these aids involve a capital expenditure, but that expenditure, depreciated over several years, is small enough to be included in the teacher's budget and need not be considered as a major investment of the school or the district.

The key decision, therefore, which the district faces in regard to this use of technology is the size of the teacher's budget or allocation. (It does not matter whether this is an actual cash budget or whether there is some limit on the size of the equipment and media order which the teacher can place, the effect is the same.)

What are the benefits from an increased allocation to teachers for their use in acquiring minor technology? The benefits are the same as those derived from having a teacher in the first place; the general benefits from the basic education process. The situation is very much analogous to trying to determine the benefits from giving an artist an allocation for his brushes. One has an artist or one does not, if you do then he should have the tools he feels are needed. The situation with teachers is a little more difficult than for the artist. The artist is an individual entrepreneur and can allocate his own resources, whereas teachers must depend upon an allocation from the district.

It is nearly impossible to judge the marginal increase in teaching quality due to the addition of a particular unit of technology. The judgment of the individual teacher must be accepted. This does not preclude efforts to educate or sell the teacher of the desirability of such units, but the ultimate decision must be made by the teacher.

In other words, the acquisition and use of minor technology should be a free market. The concept of an open market for distribution has been proven time and again as an effective way of allocating resources where individual judgment as to the quality and usefulness of the resources is paramount. The market would work like this: the teachers would be given an allowance or a budget. Potential suppliers of various units would be expected to sell the use of their units directly to teachers. The teachers would use their allowance to acquire that which they felt appropriate through regular purchasing procedures. If the allowance covered not only technological items but also supplies, texts or their own further training, then we would have a true market and the value of the technological items would be put in proper prospective relative to other uses of such funds.

This approach means that the suppliers need to have relatively direct access to the teachers. If this were the case, the suppliers would be forced to make appropriate market studies and cost analyses. Only when they saw that a market was large enough and the costs small enough to make the product worthwhile would it be produced. Thus, the cost-benefit analysis would be made automatically as a consequence of a market mechanism.

Some might argue that good teachers would use innovations more wisely than poor teachers or that suppliers would "put something over" on some teachers. These difficulties would occur, but they are inherent in the quality and choice of the teachers and cannot be solved by changing the process of introducing technology. Administrators or Federal bureaucrats are not necessarily wiser than teachers.

One could conceive of massive statistical experiments designed to see whether the students of teachers who use a certain tool do better on the whole than those who do not. The experiments would have to be massive since the "noise" level, the effects of many, many other factors, dominate. It would seem that these experiments are hardly worth undertaking when the simple expediate of providing the service on a free market basis will allow the cost-benefit judgment to be made automatically and, in effect, will force the suppliers to do the analyses through their market studies.

Cost/Benefit Analysis for Tools Requiring Large Capital Investments

There are several situations in which the teacher would like to have a particular tool in the classroom (or other learning center) but cannot acquire the tool with his small budget because the existence of the tool requires certain central supplies or equipment. In other words, they require a prior major capital investment. This is true for computer-managed and assisted instruction, for dial-access systems and closed-circuit TV. It is also true if a major expenditure is required to create a library or resource center of media from which the individual can select the software he requires.

In this situation there are two different decisions to investigate: the decision by the teacher to use a technological item which is already available and the decision by the district (or a group of districts), to acquire the central units and terminals or media necessary to provide the technology.

The first decision can be handled in one of two ways: the teacher can be given an allocation and be charged for the use of the system or the cost of the system can be included in the school overhead and provided to the teacher as a "free" good (Craig & Dietrich). In both cases the benefits are the same as for the small individual tools discussed above.

The teacher must make a judgment as to the value of the supporting process or unit in regard to his general teaching method and the overall benefit which he intuitively expects. Judgment from the district point-of view must rest on the overall effectiveness of the teacher, since the effectiveness use of the tool cannot be separated.

The second decision, is a critical one: when and how should a school district make a capital investment in an educational technology system, especially in the absence of any good benefit measures?

There are actually two ways in which a district could acquire such technology. One would be to actually acquire, buy, or lease the service itself; the second way would be to allow an outside agency to supply the service. For example, an outside cooperative or company (profit or non-profit) could provide CAI terminals within a school on a use basis. This second method shifts the situation from a capital-requiring situation to a simple use of existing tools. In other words, each teacher could judge the desirability of the use of the technology and it would be up to the outside supplier to do the necessary cost-benefit analyses and the training (selling) necessary to make the system have an overall cost-benefit result.

If the district itself is proposing to make an investment, then it must act like a supplier. One of the problems to be faced, of course, is the economies of scale (Solomon). In general, with hardware-based technology, the economies of scale are reasonably significant; larger systems cost less per unit of service than smaller units. This presents a particularly difficult problem in education because education is an intensely human, person-to-person activity and such activity generally takes place in small units; small classes, small schools, and small school districts. There is a conflict between a desire for economy and a desire to retain a loving environment. However, there is already some tradition toward joint effort between school districts for hardware systems. And also, we already have, for better or worse, a number of large school districts. These jointures or the large districts could consider making their own capital investment for technology and still obtain reasonable economics of scale. Methods for making such an investment decision have been extensively studied (Craig, Hartman, Kiesling, Kopstein, Molnar, Oettinger, Technology, Wilkinson). The following aspects are involved: 1) One or more designs for the products or services must be developed. What service is going to be delivered to the teachers and students and how? 2) Market (use) studies must be made to determine how extensively one or more of the various products or services could be "sold." That is, would the teachers, if they had an appropriate allowance, utilize the service and if so, to what extent. 3) The system must be costed. There is nothing magic in such costing. It involves estimating costs for the design and implementation of the system, and for the operating of the system. The operation of the system includes both fixed costs and variable costs. The fixed costs, in turn, include some way of depreciating the design-implementation costs as well as the actual fixed overhead for hardware and for basic staff. Included in the operating costs should be sufficient liaison (selling) effort to insure that the service has a fair chance of being brought to the attention of teachers and, therefore, of being used. (Of course, one way of selling such a service is by edict of the superintendent. However, this is actually not effective because teachers will not use a service if they do not feel it is appropriate to their teaching method even if they have to hide the fact from their department heads and the administration.) 4) Finally, a classical breakeven or return on investment analysis is made to see whether the investment in designing, installing and implementing the system will be recovered in a sufficiently short time to be reasonable. In other words, it is worth tying-up district funds in the implementation effort in the face of other alternative uses for such money. The cost reduction from a technological innovation usually has to be 5:1 or more for it to be justified in terms of an acceptable return on investment.

When considering how alternatives are viewed it should be recalled that funds are now short for schools' ordinary expenditures. "The amount of money currently projected to be available in 1975 is enough only to maintain the status quo and to go a little beyond, but not enough to revolutionize education profoundly, even if money were all it took to do so." (Oettinger)

The benefits of alternative uses of such expenditures are also difficult to judge and, therefore, the subjective evaluations of the senior staff, or representatives of the teachers and of the board must be a major input.

(Computers, of course, or terminals should be available in high schools because they are a piece of technology whose use is to be learned; like pencils, lathes in shop, typewriters, books and paint brushes. In this use they are objects to be studied, not instructional delivery processes. It is hard to see how a school can not have such laboratory units in this day.)

The argument so far, then, is that, within the existing school system framework, technology, however extensive, must be viewed as a tool which the teacher uses to improve his teaching ability as he perceives it. In this circumstance, the free market mechanism for developing implicit cost-benefit analyses seems to be most effective and requires only that teachers be given a specific allowance which can be used for various teaching aids and tools. The extent to which the funds are used for technological innovations will then be appropriate to the benefits they judge to accrue. Capital investments, by schools or suppliers, must be justified on the basis of a sufficient market at a price which covers costs so that the investment is recovered in a reasonable time.

Technology as a Substitute for the Human Teacher

Technology, particularly the more sophisticated forms, such as sophisticated retrieval systems or computer-assisted instruction, may be able to replace the human teacher. I do not mean that the system necessarily replaces the teacher in the entire school process, but in segments of it. For example, in community colleges, there is extensive experimentation using CAI or advanced CMI to teach complete topics such as psychology, algebra and chemistry -- topics which have a highly structured logic.

But there are difficulties with this form of substitution in basic education, particularly at the elementary and intermediate levels. First, however, let us look at the process of substitution at the secondary level in those areas which are highly structured. The argument runs like this; some subjects are so well formed that it is very clear what the sequence of teaching and nature of presentation should be. This is true, at least for a class of students; generally those who are neither too slow or too fast. Furthermore, with these topics, the outcomes are fairly well defined. Certain knowledges and skills are to be taught which can be measured by relatively straight-forward test instruments. This being the case, it is possible to determine whether the technological system teaches as well as or better than a human teacher. We cannot necessarily put a dollar value on the value of what the system teaches, but one can make a cost-effectiveness trade-off and indicate whether the innovation will teach approximately as well or better for a lower cost.

In this case the main "saving" or benefit is either the reduced cost or the reduced student time required. Since it is very difficult to put a dollar value on reduced student time, the analysis is a little tricky. In one sense, from the district's point of view, the reduced student time has no value, since, at present, the student must stay in school anyway for the better of his basic education career. (This fact may be one of the main reasons why technology is not seriously considered at the basic level.) If, however, significant enhancement and other alternative programs are developed and judged to be useful, the freeing of student time can be assumed to have some effectiveness and the system justified. It should be noted that this justification will be subjective and not based on dollar and utility estimates of the trade-offs.

A capital investment analysis can be made to determine whether the investment can be recovered quickly (Nance, Williamson). Boards then can decide whether they want that amount of money tied up (in exchange for the cost saving and student time release) for the predicted number of years, considering other uses for the money.

At the elementary and intermediate level, however, it is doubtful that even this form of justification can be undertaken. There are two reasons for this: one relates to the goals of elementary-intermediate education and the other is inherent in the process of teaching. One goal of basic education may be "contact with an adult." If contact with an adult, for socialization and as a role model process, is an inherent educational goal, then no form of technology can be satisfactory until we can develop completely humanoid robots! "A valid role for the teacher remains, however, as communicator model and identification figure" (Harvard, p. 39). A second goal is to impart certain knowledge and skills, both those which apply to living in the culture and those which are needed to provide opportunities for careers and voacational activities.

A third goal of the educational system is to provide employment. Although we might not create an institution only because it provides employment for people, once such institutions are created, the continuing employment both of existing and future employees becomes a non-trivial goal.

As a result of the adult contact and employment goals, it can be very difficult to justify substituting technology for human teaching. The employment goal implies that any technological system which will reduce the need for human services will be looked upon negatively by the institution.

There is, also, a technical reason why it is extremely difficult to substitute any technological hardware-software, no matter how sophisticated, for a human teacher at the elementary-intermediate level. Let us examine, just briefly, what it is we are asking a teacher to do. A good teacher is continually analyzing the linguistic statements of the child and trying to determine what topics, statements, guidance and materials should be presented to this child in order to take the next step in his learning about one or more topics or skills. The child is an extremely complex information processing organism. We are asking the teacher to analyze this complex system and to interact with it so as to accomplish a very sophisticated goal. The only computer good enough to make this analysis of the student is another human being (and probably only a capable one at that). Reference to the literature on artificial intelligence (Simon, Dryfuss) will show that we are decades, if not centuries, away from developing computation devices which can analyze even simple, logical statements let alone analyze the, often incomplete, linguistic utterances of a child to interpret them in relation to teaching needs. Thus, it is unlikely that computer-based technology will replace human teaching processes for most of the teaching activities at the elementary and intermediate levels. Research and pilot studies, however, should be undertaken to advance the concepts of an "automatic teacher."

By the time the student -- at least the good student -- gets to the secondary level he begins to teach himself. In these circumstances, retrieval mechanisms which help him find materials (text and audio-visual) appropriate to his studies might seem to be in order. Ordinary libraries and card catalogues or simple computer-based catalogues should provide all of the retrieval requirements needed.

To summarize then the arguments in relation to the substitution role of technology, it appears that both from the point of view of goals and the point of view of technical considerations, it is unlikely that technology will be available to substitute, even on a topic-by-topic basis, for human teaching at the elementary level. At the secondary level, either for certain highly structured topics or for sophisticated retrieval and identification of research materials, these arguments do not apply. However, the extent to which either of these applications reduces cost or improves effectiveness is sufficiently marginal to make the justification difficult, given the employment goal and the fact that students are required to be in school in any case.

NOTES ON COST-EFFECTIVENESS

Consider the case where the district must make an investment decision to provide tools for the teacher (or replace him/her for certain specific functions or topics). Difficulties arise from finding a benefit measurement for comparing one use of funds with another. Jamison, et al, show that a well-designed CAI system can provide arithmetic drill and practice at about $1.15 per contact hour. Low achieving students do better under this type of system; gaining perhaps a year more in standard arithmetic test scores (in a year) than without the system. But how does this compare to other alternatives, such as:

1) use of high school students to tutor elementary students,

2) use of paraprofessionals or volunteers,

3) giving students rewards (e.g., tokens for toys) for good work,

4) heavy parent involvement?

Let us consider how to look at such alternatives.

Cost Aspects:

Cost models used in all studies that have made cost analyses use standard industrial methods for estimating the total operating cost. This includes repayment of initial investments. It is true that schools do not always have the data for making the analyses (neither does industry); but close "guesstimates" are usually sufficient for initial analyses.

Formal education implies contact between a student and a teaching system. Thus, a basic measure of cost is dollars-per-student contact hour. If the system causes a student to do more studying on his own (or in other contexts), that is a benefit but not a cost factor. The cost per student hour should include cost reductions effected by the system as well as increases. A reduction could come from allowing a higher student/teacher ratio.

A decision situation would generally look like Figure 1. The points are **total** school (or program) costs with various proposed new systems. X is the present system.

D and E alternatives are clearly worth considering. They do as well or better for less cost. The only reason not to implement them is that the investment -- the transition costs -- are too high, and cannot be funded.

A and F are never justifiable.

C would be justified only if cost reduction were so essential that a reduction in performance were tolerable (and there were no D and E alternatives).

The choice of B or H depends upon the value subjectively placed on the added performance, and on the magnitude of the investment.

Table 1 shows some typical costs.

Risk

In addition to costs and benefits, a decision-maker is faced with risk (expressed as a probability distribution). He is uncertain as to costs and benefits that will actually result from an investment. In education, risk is not discussed much because, on one hand, costs can be estimated with no real uncertainty. On the other, benefits cannot even be described, let alone assigned a risk.

Individuality

The most important thing about education is that we want to treat the subjects of the process as individuals. Figure 2 is a concept to help discuss this problem.

The benefit dimension is imagined to be a measure of the extent to which learning takes place in a given time (e.g., a year) or the time it takes to learn a prescribed amount; a performance-time measure.

Curve A is a good student, he learns just about everything we want him to learn in regular school; at about $1.00/student hour.

Curve B is the slowest student still likely to learn in regular school. He makes some progress at regular expenditures, and could do better with somewhat more effort ($2-3 per student hour). C is a student who needs intensive help -- now normally arranged by small group (5:1) efforts or part-time tutoring (Bloom).

Table 1

Typical Costs

Process	Cost	Time unit	Cost/Student-hour
General school	1,000/Stu-yr.	180 days x 6 hours*	.93
Teacher salary in 25:1 class	12,000/yr. for 25 students	180 days x 6 hours	.44
Individual tutor	20,000/yr.	180 days x 6 hours	18.50
Audio-visual center	(see article by Nance)		.25
Good CAI system[1]	10,000/yr. for 8 terminals**	180 days x 6 hours	1.16
Speculative CAI system[2] (Plato IV)	------	-------	.34

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* Effective time is less (less than 180 days due to absence, less than 6 hours due to non-teaching periods); costs are therefore actually higher.

** Does not include all the overheads necessary, if treated as a pure substitute for a school.

[1] Jamison

[2] Bitzer (unpublished); reported in 1.

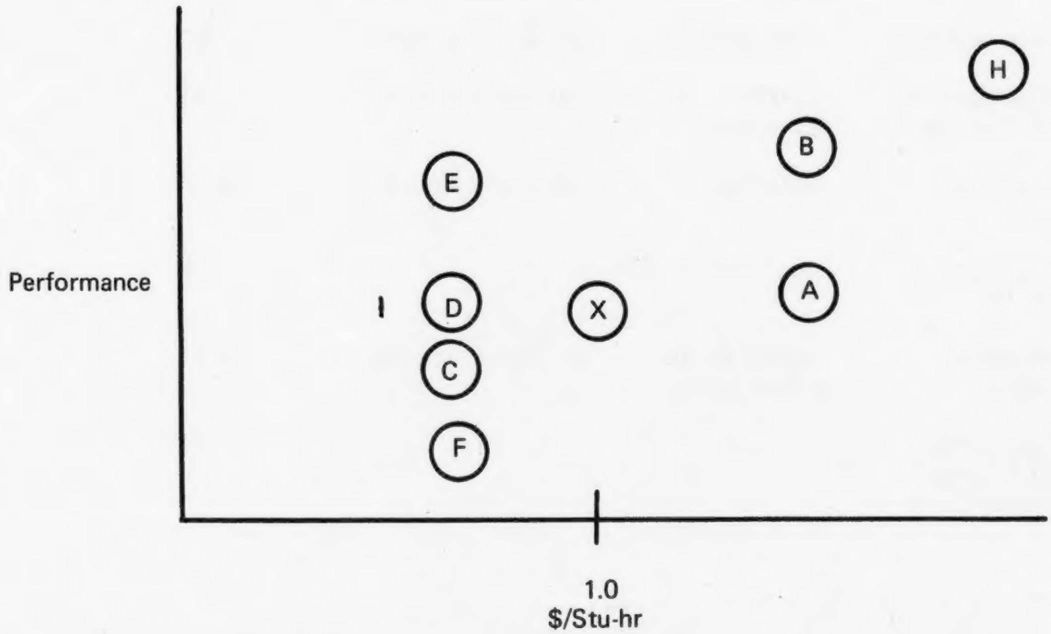


FIGURE 1

Figure 2

Performance-Effort Relationships for Students With Various Genetic and Pre-school Endowments

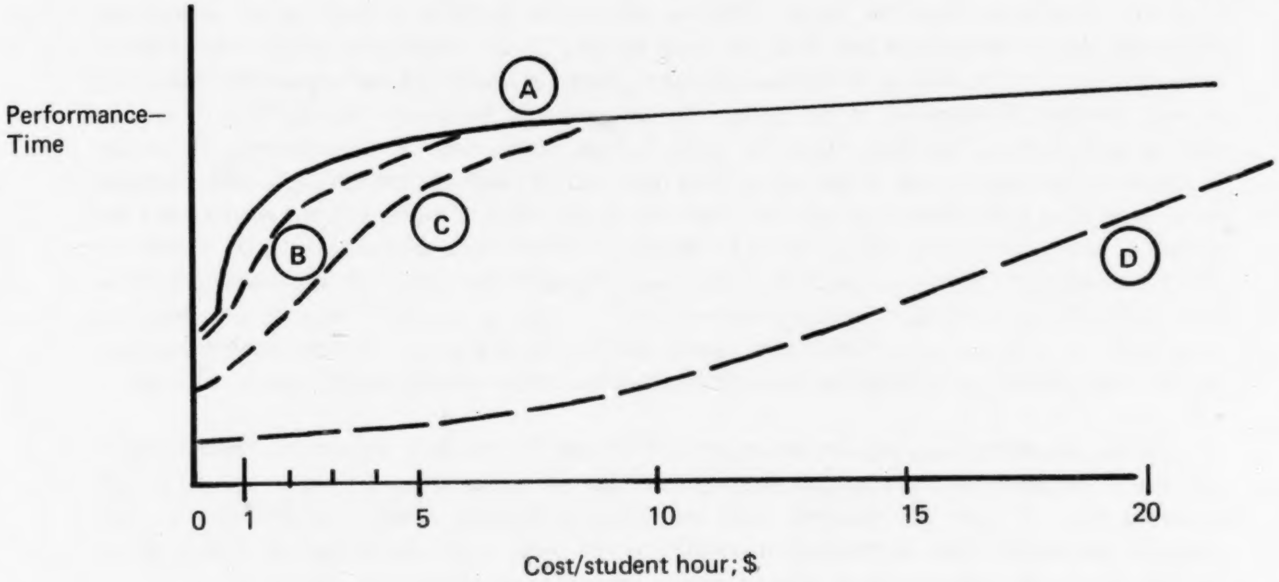
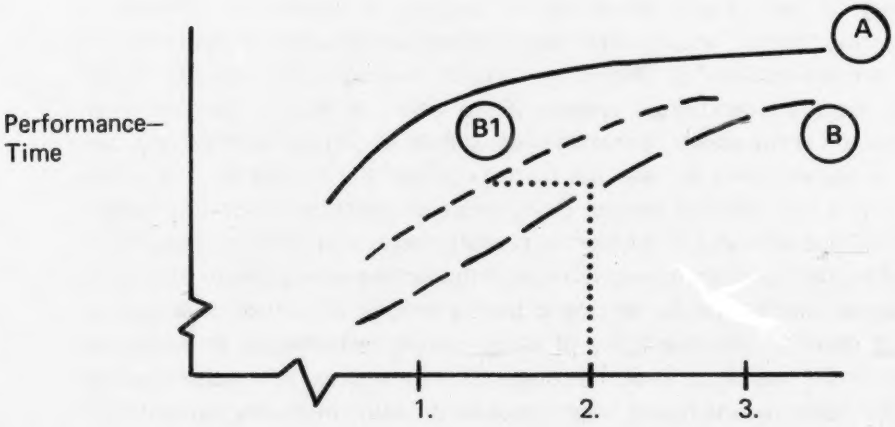


Figure 3

Effect of Technology – To Produce the Same Performance at a Lower Cost



D is a retarded student who requires 1:1 help to learn even some basic skills. The oversimplification is clear (Craig, Hartman, Kiesling, Kopstein, Molnar, Oettinger, Technology, Wilkinson). The following aspects are involved; 1) One or more designs for the products or services must be developed. What service is going to be delivered to the teachers and students and how? 2) Market (use) studies must be made to determine how extensively one or more of the various products or services could be "sold." That is, would the teachers, if they had an appropriate allowance, utilize the service and if so, to what extent? 3) The system must be costed. There is nothing magic in such costing. It involves estimating costs for the design and implementation of the system, and for the operating of the system. The operation of the system includes both fixed costs and variable costs. The fixed costs, in turn, include some way of depreciating the design-implementation costs as well as the actual fixed overhead for hardware and for basic staff. Included in the operating costs should be sufficient liaison (selling) effort to insure that the service has a fair chance of being brought to the attention of teachers, and therefore, of being used. Of course one way of selling such a service is by edict of the superintendent. However, my argument here is that this is actually not effective because teachers will not use a service if they do not feel it is appropriate to their teaching method even if they have to hide the fact from their department heads and the administration. 4) Finally, a classical breakeven or return on investment analysis is made.

Where can technology help in this spectrum? For an "A" student - not much. These students can learn from books and by exposure to people and general media. It is my opinion (but this needs research) that "C" and "D" students must be helped by humans. There is a possibility the "B" students can benefit from technology; it could raise the curve to B1 (see Figure 3). This is in fact the role of a capital intensive technological change - to produce an output for less input.

Thus, technology should be chosen where it will help marginal students with specific topics or skills and is effective -- it teaches at least as well as a human and costs significantly less than the special help would cost, if provided by humans.

TECHNOLOGY DECISIONS IN SCHOOL DISTRICTS

These arguments would lead me to believe that the critical decisions which a school district must make are the following: a) Will it give allowances or budgets to teachers (or perhaps to departments) for use in acquiring "tools," among them being various technology-based devices and media. If so, what budgets are appropriate? b) Should the district investigate the value of investments into those tools which require a centralized system? (Should they do this on their own or in combination with other districts?) If the answer is that they do wish to undertake such a study, one of the first critical steps is a market analysis: will the teachers within the district(s) utilize such innovations? (Needless to say, a high quality market study must be performed not just simply guesses, prejudgments or unsounded surveys.) If the market is there, the cost-benefit analysis should be carried out using standard capital investment procedures as if the service were going to be sold to the teachers, whether the actual mechanism for pricing is from a teacher allowance or as part of overhead. c) A district could consider the possibility of using certain technologies to substitute partially or fully for teachers at the secondary level. The procedures for making this decision would have to depend heavily on administrative and board judgment as to the value of freeing student time from one activity for another.

PILOT STUDIES IN EDUCATIONAL TECHNOLOGY

Within the assumptions made at the beginning of this paper, it would appear that several pilot studies might be useful. The first step, preliminary to pilots, would be extensive market studies to estimate how teachers would use an allowance if they had it and what this implies for technological tools. Such studies would have to be made carefully, since we want to determine how teachers would allocate their allowances **after** they had become aware of the various tools which could improve their teaching processes (and not based on their current purview which might be quite limited). Such studies are done all the time in the private sector and should present no serious problem.

If studies show that there is no market, further development of the technology and/or more extensive and intensive pre-service training is indicated. If a market does exist, teachers **are** interested; then several pilots should be undertaken.

In a series of pilots, teachers would be given varying levels of allowances for use in acquiring tools. These experiments would have to extend over a long enough time and be extensive enough to make it worthwhile for suppliers to organize to meet the market.

If a pilot requires some major investment, extensive financial support is required. There are, however, pilots throughout the country where one or another form of technology is already in existence, so that no significantly new capital investments should be required to test the market in these cases. (A good survey of such pilots is needed.) If the market studies indicate that teachers would, with a real or implicit allowance, utilize certain technologies which require a capital investment, and there are no existing pilots available, it would be worth creating such a pilot to confirm the actual usage and to obtain their evaluation of the benefits.

Based on these pilots and on studies being undertaken at the community college or undergraduate level, it should be possible to tell the extent to which teaching costs can be reduced and student time made available for other studies. If the direct cost reductions are at all significant (better than 3:1) the innovation should be adopted. If students' time is released, a further study should be made to determine how students, teachers, administrators and boards see the alternative uses of the students' time. Only if there are obvious beneficial alternative uses of the time would detailed cost studies or pilot experiments be undertaken.

CONCLUSIONS

It is unlikely that any form of educational technology will become a substitute for good teaching. The burden of identifying, training and employing good teachers in our school system still exists. Good teachers may decide to utilize technology as tools to improve their own activities, if they are given some support for this in the form of leadership and budgets. Cost-benefits for such tools should be found by creating a market mechanism. The use of technology to substitute for teachers needs further development.

APPENDIX

Some writers imply that technology can in itself cause change. As discussed below, educational technology is unlikely to become a lever for instituting political or systemic change. If a governmental jurisdiction were to choose to invest major resources in an alternative educational system which happens to involve technology then technology would be a rationale but not a basic cause.

Significant changes in the technology used for general communication (mass and personal) would, of course, affect education. Basically they alter the environment of the students. The Electric Factory and Sesame Street, as software aimed at children, came after the general technical change, TV. They affect children, like TV in general or drugs, and therefore, change what the school has to cope with (for better or worse). The next such change may be extensive two-way cable (or very short microwave) TV. This would certainly offer opportunities for new forms of basic education. But such an innovation is unlikely to be instituted because of basic education. (It is probably 20 to 30 years off anyway.)

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ECONOMICS AND EDUCATIONAL TECHNOLOGY IN THE UNITED STATES

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INTRODUCTION

Why bother with economics in a conference on educational technology and productivity? What can such a hedonistic social science contribute to the understanding of a fundamentally human activity such as education? These are very good and important questions which we shall address at the outset of this paper.

The application of economic principles to education questions goes back at least as far as Adam Smith, the founder of modern economics in the 18th century. Yet, it is only recently that there has been a widespread attempt to apply both empirically and theoretically the tools of economics to questions concerning education.

The problems of adapting general economic principles to the particulars of the education mileau are formidable.[1] Education after all is not a run-of-the-mill industry like steel or corn. First, education is a multifaceted activity with many desired outputs or objectives, most of which are related to personal human characteristics rather than hard physical objects. The economic calculus, after all, generally deals with costs of inputs such as land, labor, and capital and the monetary value of outputs such as goods and services. Nevertheless, economics now deals with multiproduct firms such as General Motors which produce thousands of different goods and services -- including many types of education. Economists are now applying their tools with some considerable success to many service and human industries and activities such as, to name a few, medicine, government, nutrition, research and family planning.

Some would assert that since education is required by law for all citizens of the United States, such economic concepts as supply and demand would not be operative. However, many activities which are proscribed or prescribed by law are analyzed successfully with the use of economic tools including those of supply and demand. The fact that government is required to provide education makes the whole area of economics dealing with monopolistic organization extremely relevant, not to mention that of public finance.

For a final item, it is often put forward that education is an activity for which a variety of motivational factors are important, not just that of maximizing profits or welfare as economics assumes. Economics has recently become more and more concerned with a wide variety of human objectives, because of a recognition of the limitations resultant from simple profit maximazation as the human motivation. On the other hand, profit maximazation theory has been found to yield many important insights into a wide variety of problems and areas within the educational system.

KEY DEFINITIONS

Probably as many definitions of some of the key terms being used in this conference exist as there are persons here. An economist has certain definitions which are found useful for the concepts that he is interested in that may be worthwhile to present for general discussion.

Technology is defined as **a set of inputs of specified proportions and the way in which they are put together to achieve a given output.** Thus, a teacher, thirty students, a set of textbooks, a blackboard, a classroom, and paper and other such materials is one technology. Another technology is a set of computer terminals, twenty students, a set of programs and a room to hold them. Thus, as many technologies exist as there are ways of combining the various ingredients of education: teachers, students, texts, materials, buildings, equipment, administration, etc. Of course, not all combinations are operative technologies. However, it is useful to keep this very broad definition in mind when thinking about education to assure the maximum open-mindedness toward the structuring of education.

Productivity is a concept that has many variations. In general, **productivity** is defined as **the amount of output or results obtained for a given amount of input.** Consequently, a different type of productivity exists for all combinations of inputs and outputs. For example, there are the productivities of: math achievement per teacher, math achievement per textbook, math achievement per computer hour, reasoning improvement per teacher, reasoning improvement per student and promotion per television set or series. In addition, there are aggregated productivities in terms of various outputs per dollar of expenditure on all inputs. The importance of the recognition of this variety is in assuring that conversations about "the most productive inputs" or "the most productive method" do not miss each other in the dark due to different variants of productivity being used by the participants in the discussion.

The enormous set of technologies and productivities just described leads to the importance of the prices of inputs in any decision making about education. One cannot conclude that any given technology is the "best" or any given input the "most productive" without considering the prices of the inputs. The term efficiency as used by economists summarizes this concern.

Efficiency is the attainment of the **maximum possible output with a given amount of inputs or** the attainment of **a given output with the minimum possible amount of inputs.** Both inputs and outputs can be as broadly defined as desired. Outputs can include physical, emotional, or any other identifiable things while inputs can include labor, capital, materials, emotions, nervous energy, etc. The cost of inputs is needed in dollar or other terms in order to make comparisons of efficiency and therefore of desired technologies. **Technological progress** is **the development of new ways of doing things,** such as computer display screens, and new teaching methodologies, such as the open classrooms. Technological progress, by changing the range of options open to decision makers, causes continual change in what is and is not efficient in education or any other sector.

CHARACTERISTICS OF THE UNITED STATES EDUCATION SYSTEM

The education system in the United States is in many ways unique in the world. To discuss most usefully the uses of technology and the productivity of the system, a review of some of the aggregate characteristics of the system is required. Indeed, some general attributes of the economy as a whole are extremely important for a full appreciation of the role of technology in education.

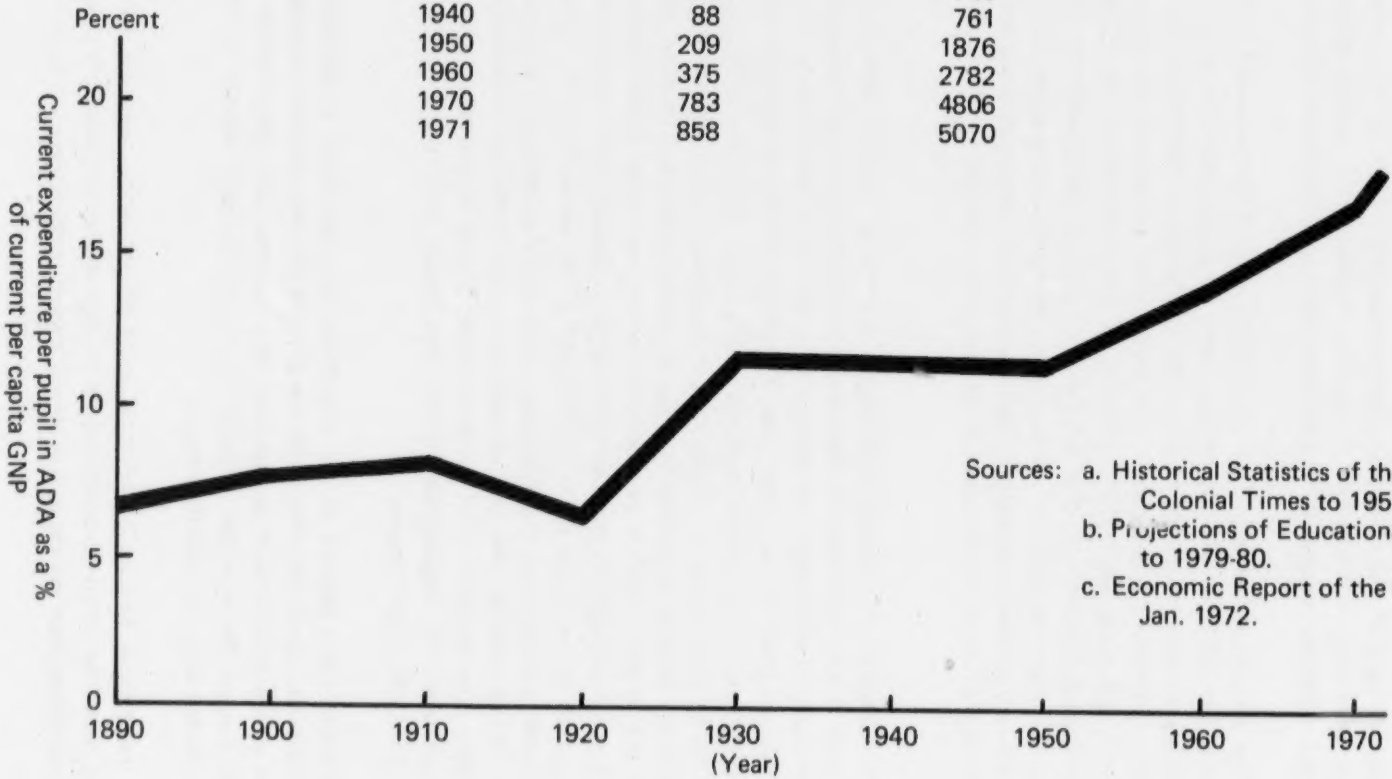
The first important fact about our education system is the tremendous amount of money that is spent on it. In 1971-72, $47 billion was spent on public elementary and secondary education alone. Probably an amount almost equal to that was spent on other education -- higher, vocational, and private elementary and secondary. The average cost per elementary and secondary student in public schools was more than $1,000. For higher education it was over $2,500. These somewhat staggering amounts demonstrate that education is a big business and that a tremendous national commitment has been made to it. However, to put things into perspective, the total expenditures on public elementary and secondary school was less than five percent of our gross national product and $1,000 per student year is only about $1.00 per hour, not that much different from baby-sitting costs.

Another attribute of American education is the high ratio of labor to capital and capital to materials costs. While this is typical throughout the world, unlike the uniquely high aggregate and per student cost of education, our system does not go to the extreme of many less developed countries. Nevertheless, the fact that over 75 percent of educational expenditures at the primary and secondary level are for salaries is an immensely important characteristic of the system. It means that labor (in its broad sense of people's time) is the single most important input in terms of dollar value. The share of total expenditures going to capital depends, of course, directly on the rate of growth of the system. Capital expenditures are of two types: direct expenditure for new construction that is being paid for from current budgets, and payment of interest on borrowing for past or present construction. Since the rate of growth of the elementary and secondary school population has slowed to about zero, the necessary new capital expenditures should decrease at these levels (there will always be some new capital construction due to shifts in population and depreciation of old buildings). The growth rate of **necessary** expenditures on capital at the higher education level will continue high and possibly even climb. The **actual** expenditure on capital in the future will depend on the technologies chosen.

Only about three percent of the elementary and secondary school budget for 1972-73 was spent on materials (texts, libraries, audio visual materials, and teacher's supplies). Since such a small proportion of the total is spent on materials, this is an area with great leverage potential. One could double the budget for materials without having an immense impact on the total budget. This freedom does not exist for the other inputs.

The tremendous proportion of total costs of education used for labor instills a constant cost-raising bias. The annual expenditure for a single elementary/secondary student as a proportion of gross national product per capita has almost tripled in this century. Figure 1 illustrates this trend.

Year	Current expenditure per pupil in ADA, $'s	Current per capita GNP, $'s
1890	14	210
1900	17	231
1910	28	349
1920	54	835
1930	87	740
1940	88	761
1950	209	1876
1960	375	2782
1970	783	4806
1971	858	5070



Sources:
a. Historical Statistics of the U.S., Colonial Times to 1957.
b. Projections of Educational Statistics to 1979-80.
c. Economic Report of the President, Jan. 1972.

FIGURE 1

Reference: This figure is reproduced from Productivity and Efficiency in Education, U.S. Government, forthcoming.

There are two important reasons for this. First, the average student to teacher ratio has steadily declined and, second, teacher salaries have risen rapidly, particularly in the last decade. As long as education maintains a constant or increasing labor/student ratio, while other products decrease the amount of labor per unit of output by utilizing more capital, the cost of education will continue to rise both absolutely and relatively.

The interrelated attributes of diversity and decentralization constitute a third characteristic of our education. While federal funds account for about ten percent of total expenditures, it is clear that we do not have in any sense a federal system of education. In 1971-72, almost 17,000 public school districts having almost 100,000 elementary and secondary schools were in operation. In addition, almost 20,000 non-public schools were operated through a number of administrative arrangements. Added to these are 2,300 institutions of higher education and thousands of vocational schools.

This diversity and decentralization have two important implications for the present topic: 1) a great variety of technologies, which can provide evidence on the efficacy of hundreds of different approaches to various education problems, are being employed at any given point in time in schools and school systems around the country, and 2) it is extremely difficult administratively to implement on a large scale changes in individual systems that have proven effective. At the end of this paper we shall return to some of the implications of these attributes in a discussion of research and incentive systems in education.

Finally, the U.S. has an incredibly rich endowment of human resources and knowledge. While it is difficult to say much of a quantitative nature about our endowment of knowledge, statistics on our human resources are available and worth repeating. Of the 111 million adults 25 years of age or over in 1971, 62 million had finished four years of secondary school or more, the majority of whom had obtained some higher education, including fully 12 million who had completed four or more years of college. Thus, a total of 56 percent of our adults had 12 or more years of education. In 1971 alone, we graduated 829,000 individuals from college, another 300,000 received advanced degrees. In addition, over ten million individuals were enrolled in vocational courses. Thus we are in a position of having an extremely well educated labor force, undoubtedly the most highly educated labor force of any country in the world.[2] Consequently, the ability of the labor force working in education to adapt to changes in technologies and of people working in government, industry, and education to develop new ideas, materials, and equipment is probably the best in the world.

Unfortunately, a counter-balancing force exists which is equally important. The United States labor force in general and the education system's labor force in particular are highly organized by professional associations and unions and becoming more so. Given the job security provisions in the contracts of most teachers and the decrease of new hiring due to the reduced population increases at the elementary and secondary levels, the freedom to adopt new technologies is often severely proscribed because of an inability to reduce the utilization of labor.

THE USE OF ELECTRONIC TECHNOLOGIES

Introduction

The use of electronic technologies such as television and computers is what many people have in mind when the phrase "educational technology" is mentioned. Before examining these and other technologies from the economist's perspective, however, some background information must be provided.

One difficulty of dealing with electronic technologies in education is that their cost and hence their efficiency is often dependent upon the scale of the operation. For television and computers alike, the cost per unit falls markedly as the amount of use goes up over a wide range. A point is eventually reached where this trend is reversed due to the lower population density encountered as the area covered increases. Therefore, one almost has to consider undertakings of different sizes as requiring different technologies even if the nature and proportion of the inputs are exactly alike. A given technology utilizing a certain number of hours of television programming per day may be efficient for a school population of 100,000, but not for 1,000.

The problem of scale is important not only for capital goods or electronic technologies. It can be just as important when considering the software utilized in a computer or television oriented technology or a traditional classroom. (Hardware is the equipment such as television sets and transmitters, computers, projectors, or books; while software is material and concepts which are presented via the hardware: the content of books, the television programs, and the computer programs.) For software also, the greater the number of users, the less the cost per user. This scale effect is further detailed and illustrated in Table 1 and its footnote. The importance of this is related to the costs of producing the software in terms of research, writing and filming effort, etc. The cost of a television set is not, after all, the value of the receiver and the cost of the electricity to operate it, just as the cost of a book is not just the paper and binding.

A general difficulty observed in trying to cost capital intensive educational technologies is the proportion of the cost of some of the components of the system to be charged to the educational use when the system is also used for other purposes. For example, if a television channel is used for only part of the day for educational purposes, should the television studio, the transmitter, or the electric power capacity necessary to transmit those programs be charged partly or completely to the programs? This question becomes even more confusing when the possibilities of utilizing existing facilities is compared to building new ones when no capabilities exist. The difficulty of these questions is reflected in the lack of any generalizable answer. Decisions as to what costs to include have to be made on an ad hoc basis and due to lack of space we cannot go into this in detail. Nevertheless, it is important to bring up that one must always be aware of what those decisions were when making comparisons of alternate technologies, so that no technology is unfairly handicapped in the competition.

Television

Our discussion of television begins with a synopsis of recent reviews concerning the relative pedagogical effectiveness of TV versus traditional instruction. This gives the benefit side of the cost-benefit relationship needed to evaluate the efficiency of programs. We then discuss several experiences where TV has been used for various purposes: 1) improvement of formal schooling, 2) extension of formal schooling to previously excluded groups, and 3) non-formal education. Finally, we discuss the cost of providing instructional television (ITV), and compare it with the cost of instructional radio. While space limitations preclude this paper from discussing the potential for radio (or other audio) technologies, we do feel them to be neglected in the current emphasis on television and computers.

Pedagogical effectiveness. Jamison, Suppes and Wells[3] provide a recent review of three surveys of comparative effectiveness studies of ITV. They synopsize these studies as follows:

> "Chu and Schramm[4] surveyed 421 comparisons of ITV with TI (Traditional Instruction) [one teacher in a class of about 20-40 students] that are reported in 207 separate studies. Their results indicate that students at all grade levels learn well from ITV, though this seems somewhat less true for older students than for younger ones. The effectiveness of ITV cuts across virtually every subject matter. Dubin and Hedley[5] provided a more detailed survey of the effectiveness of ITV at the college level. They reported on 191 comparisons of which 102 favored ITV and 89 favored TI, although most of the differences were insignificant at standard levels of statistical significance. When data were available, Dubin and Hedley extended their comparisons to include the distribution of statistics of the individual comparisons of ITV and TI; in this way it was possible to weight appropriately differences in performance of differing degrees of statistical significance. The results of this analysis, applied to all their data, indicated a slight, but statistically significant difference in favor of TI. When studies of two-way TV were dropped from this sample, the overall comparison yielded a small, statistically insignificant advantage for TI.
>
> "An unusually stringent criterion for interpretability of results was utilized by Stickell[6] in comparing ITV to TI, and it is worth commenting on his survey here. After examining 250 comparisons of ITV to TI, Stickell found ten studies that fully met his requirements for adequate controls and statistical method (interpretability) and 23 that partially met his requirements. Schramm provides clear tabular summaries of these studies. None of the fully interpretable studies and three of the partially interpretable ones showed statistically significant differences; each of the three statistically significant cases favored the ITV group. It should perhaps be noted that when highly stringent controls are imposed on a study, the nature of the controls tends to force the methods of presentation into such similar formats that one can only expect the 'no significant differences' that are in fact found. When ITV is used in a way that takes advantages of the potential the medium offers -- as, perhaps, with Sesame Street -- we would expect more cases of significant differences between the experimental group and the 'alternative treatment' (for it would not be a 'control' in Stickell's sense) group."

We thus see that TV can be pedagogically effective though it has not, on the average, been more effective than traditional instruction. This conclusion suggests that TV can be used either to improve quality by only selecting those programs proven to be highly effective or to reduce cost if conditions permit. In other words, since the benefits of ITV are about the same as TI, the costs of the two technologies determine relative efficiency. We now turn to a brief survey of a number of ways in which TV has been used for instruction.

TV for improving formal education. TV has been used in this capacity in a broad variety of ways ranging from occasional classroom supplements to its use as an integral part of massive educational reform. Most experience with the latter has been in developing nations -- Niger, American Samoa, El Salvador and the Ivory Coast. In the U.S., the Washington County, Md. (Hagerstown) project perhaps comes closest to such an extensive use. That system has been in operation for almost 18 years now and the Hagerstown school administration feels that they have been able to provide quality instruction in a wide variety of subjects for a rural area in a way that would have been financially infeasible with conventional instruction.[7]

The experiences of the developing countries have varied. Niger's system never passed a pilot stage even though the programming for it was widely acclaimed as imaginative and effective. American Samoa's system has now been in operation for almost a decade and has transformed the elementary and secondary education of that island's 8,100 students. Schramm[8] summarized lessons from the Samoa experience; the students appear to be learning, but the system has a number of important shortcomings.

El Salvador began intensive use of TV in grades 7-9 about five years ago with financial and technical assistance from AID. The final report (in preparation) of an in-depth evaluation of the effects of the Salvadoran reform concludes that student learning and aspirations went up and that per student costs may well go down because of other, mainly unrelated changes accompanying the introduction of TV.

A massive reform of elementary education in the Ivory Coast is now in its second year and is reaching about 35,000 students in the first and second grades. Coverage will be expanded to the remaining four years of elementary school and to all of the country in the coming years. A recent study suggests that the costs of ITV in the Ivory Coast are much higher than elsewhere and much higher than the planned figures quoted later in the section.

ITV for extending the reach of the formal education. Perhaps the most exciting use of ITV is to provide education to students outside the formal educational system. The British Open University (which uses radio, correspondence, and tutoring as well as TV) is perhaps the best known example of this; the O. U. reaches 42,000 students from all walks of life, including jails, and even has correspondence students in the U.S. In Bavaria lower secondary students learn from the "Tellekolleg"; in Japan secondary students can earn a degree by TV, radio and correspondence from NHK Gakuen; Thailand has an Open University in Bangkok; Israel plans to start an Open University; The University of Nebraska has similar plans. There are additional examples and, if recent trends persist, many new examples will be available by the end of the decade.

This use of ITV -- extending the reach of formal education -- shows promise of being the most cost-effective use and much more careful study of its economics is required.

Non-formal education. TV has been widely used for specific training courses, adult literacy, in-service teacher training, and agricultural extension work. Perhaps the best example in the U.S. is that of Sesame Street; space limitations forbid our dealing at any length with this use of TV, so we simply note that economic analysis of this use is almost non-existent.

Costs of ITV & IR. We now turn from effectiveness and uses of ITV to its cost; we also include a discussion of IR (Instructional Radio) costs at this point to form a basis of comparison.

For a general feeling for the magnitude and relationship between the costs of ITV and IR, a study by the General Learning Corporation[9] is useful. They estimated the costs of different instructional media systems for different audience sizes and different levels of program production quality, assuming rather extensive production -- from 1,000 hours (for a small population) to 1,600 hours (for a large population) -- of instructional materials, distributed through 12 grades of school. Costs per student at the higher ranges of student utilization increase somewhat due to the additional signal distribution costs of broadcasting to a lower density population (there is also an assumed increase in program quality for metropolitan regions and larger, but this factor merely slows the rate of decrease in program production costs per student and is not the cause of the trend-reversal). Examining these system costs on a per student-hour-viewed basis shows that for reasonably large audiences (city and larger), the costs of ITV run three to five times greater than those of IR -- ranging from five cents to ten cents per student-hour for ITV and from one and one-half cents to two and one-half cents per student-hour for IR.

The cost estimates developed in the General Learning Corporation study discussed above were for hypothetical systems and oriented mainly towards the needs and capabilities of a relatively developed nation. The use of these technologies in developing countries, where information on costs that have actually been incurred is available and different types of media systems would most likely be used (e.g., open-circuit VHF ITV), is perhaps of interest. Furthermore, since there is often a considerable difference between costs in theory and costs in practice, this type of analysis is essential.

Jamison and Klees[10] examined cost case studies for five ITV projects and three IR Projects and attempted to put the data on a comparable basis. Their summary table is reproduced here as Table 1 and their relevant concluding comments are here as follows

"1) It is realistic to expect the costs of instructional television to range from one and one-half cents to fifteen cents per student per hour, depending most importantly on the number of students in the system. The low end of this range can only be reached if close to a million students are using the system in a reasonably compact geographical area.

2) It is realistic to expect the costs of instructional radio to range from one-third cent to three or four cents per student hour, about one-fifth as much as instructional television. The high end of this range can be reached with very small numbers of students (several thousand); the low end might require several hundred thousand."

TABLE 1

COST SUMMARY OF 5 INSTRUCTIONAL TELEVISION AND 3 INSTRUCTIONAL RADIO PROJECTS [a, b]

Project	Year of Information Source	N	h	F	V	AC	AC/V	Student-Hr. Cost
A. ITV								
Columbia	1965	275,000	50.25	624,000	.859	3.13	3.95	.062
American Samoa	1972	8,100	145	1,268,000	3.06	159.60	52.2	1.10
Mexico	1972	29,000	360	598,000	4.23	24.85	5.87	.069
El Salvadore (Sec. Only)	1972	48,000	170	1,116,000	1.10	24.35	22.14	.143
Ivory Coast	1970	745,000[c]	180	2,454,000	3.98	7.27	1.83	.040
B. IR								
Thailand	1967	800,000	25	100,400	.221	.347	1.57	.014
Mexico	1973	2,800	233	37,700	.11	13.57	123.40	.058
Indonesia[c]	1971	1,200,000	100	102,400	.32	.41	1.27	.0041

[a] Values in this table were computed with a social discount rate of 7.5%; all values are in 1972 U.S. dollars

[b] The symbols are defined as follows: N = number of students using project (in the given year, unless otherwise noted); h = number of hours per year a typical student views programs; F = annualized fixed costs; V = annualized per student variable costs; AC = average cost per student for the given value of N; and the student-hr. cost is the cost per student-hour of viewing for the fiven value of N. The model underlyning use of F and V to characterize the cost behavior of the system is an approximate one assuming that total cost = F + VN. Since average cost equals total cost divided by N, AC = F/N + V.

[c] The Indonesia figures are based on a planning study, not project experience.

SOURCE: Jamison and Klees (1973, Tables III.1 & 2)

The cost estimates made by Jamison and Klees (except for American Samoa's ITV project and Mexico's IR project which have abnormally low student utilization rates) seem to compare reasonably well with the estimates made by the General Learning Corporation study.

Computer-Assisted and Computer-Managed Instruction

Computer-assisted instruction (CAI) and computer-managed instruction (CMI) are the most recent and sophisticated developments in instructional technology. We discuss them only briefly here as actual school system experience where their use has been quite limited. Nonetheless, evaluation of some of the early curriculum development efforts suggests substantial promise and, as the price of CAI and CMI can be expected to continue declining, it seems inevitable that the future will see much more intensive use of these technologies.

Jamison, Suppes, and Wells provide what is perhaps the most complete available review of CAI effectiveness studies.[11] They conclude that elementary school drill as well as practice programs in reading and mathematics are capable of providing slow learning students with effective (though not dramatic) compensatory education. This finding is of particular significance in light of the generally negative findings surrounding most compensatory education programs. At the higher education level there are more diverse experiences with CAI including a number of examples of its being used to reduce substantially the time required for students to complete certain blocks of curriculum material.

CAI use is another area where the economics of educational technology remain to be fully explored. We would speculate that the most cost-effective uses of CAI in the next few years will be to meet legitimate social demands for compensatory education and to reduce the learning time required of people whose time has high value. The range of cost-effective uses will expand as prices decline; Ball and Jamison[12] discussed present prices and concluded that a cost of $0.85 per student contract hour is feasible if terminals can be utilized 2,000 hours per year. More optimistic cost estimates have been made, but their justification seems somewhat dubious for the present.

There is less experience with CMI and almost no reported formal evaluation of it. CMI differs from CAI in that the computer provides students with individualized instruction on an off-line basis; individuals interested in descriptive material concerning five CMI projects in the U.S. are referred to Baker.[13]

Summary

To summarize the discussion of capital intensive technologies, it was seen that they can do the job of teaching many different things to many different types of students. At present only technologies utilizing IR seem to have a distinct advantage over TI when costs are considered. However, it would seem clear that given the probable decrease in costs of ITV, CAI, and CMI with experience in their use and the certain increase of TI costs due to salary increases over time,[14] the balance will undoubtedly tilt in favor of greater use of these capital intense technologies in the future.

OTHER TECHNOLOGIES

In addition to the electronic technologies discussed above, a number of other alternatives to traditional instruction exist in varying levels of development and use. Very short descriptions of some of these are now presented.

Mix of Student-Teacher Ratios

Increasing the student-teacher ratio seems to be the most certain method of reducing costs of education. Available evidence from hundreds of comparisons over the last 50 years does not indicate that more students per teacher affects the cognitive learning of the students -- about as many studies show improved as well as decreased cognitive learning.[15] However, some studies do suggest that at the lowest grades both cognitive and interpersonal aspects suffer with larger class size. The variety of possibilities in terms of using combinations of teachers, master teachers, teaching assistants, and non-professionals makes the variety of possibilities for increasing student-teacher ratios almost infinite when "teacher" is taken to mean expenditures on personnel working in the classroom. Especially at the levels above the first few grades, this area of technological change seems to be the most promising since it directly impacts on the factor that makes up the greatest portion of the costs, the expenditures per student on teachers while having no effect on the benefits.

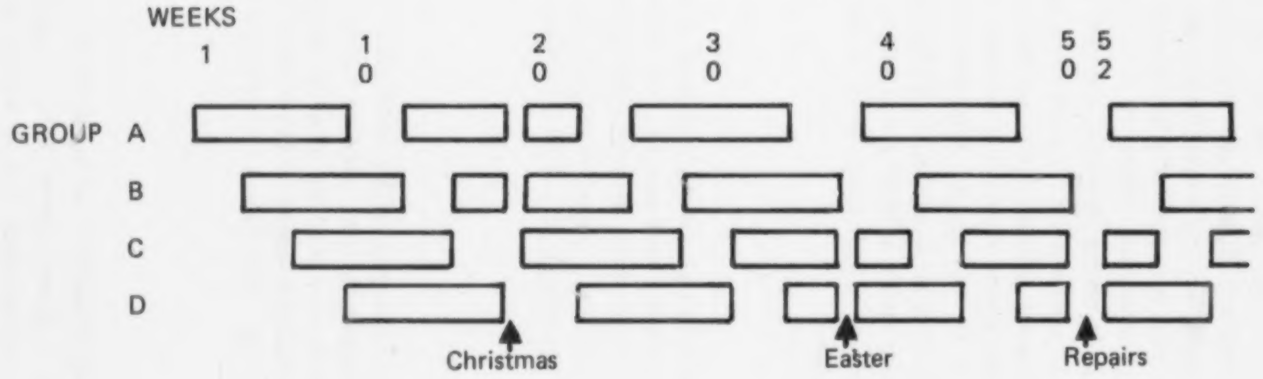
Year-Round School

A technology with some potential for reducing costs is the year-round school. Several variants of this idea are operating in the United States but the one with the greatest probable impact on costs per student is the model in which each student attends only a portion of all of the sessions of the year.

At the elementary and secondary level this is generally the 45-15 plan wherein each student is in school for nine weeks and off for three. Figure 2 shows the general format for this plan. This allows four students to utilize the space that each three students occupy under the present system since four groups of students are enrolled but only three are in residence at any time. The savings generated are in terms of less capital (buildings and equipment) and materials being required for a given number of students. Extensive information on year-round education is available from the National Council on Year-Round Education.

At the higher education level, Year-Round Education usually takes the form of a student attending two of three,or three of four,equal periods during the year. These plans save on capital and materials and have the potential of saving on the time of students which is often of considerable value for those at the higher education level.

FIGURE 2



Programmed Instruction (PI)

In terms of results, it has been found that PI is efficacious in a variety of settings for a wide variety of materials. In a survey of over 100 studies comparing learning utilizing PI and TI, Lange[16] found that 41 percent showed PI to be superior and only ten percent found TI to be better (the other 49 percent found no difference). Surprisingly, there seems to be almost nothing available comparing the costs and the benefits of programmed instruction. It is clear that the development of programmed textbooks is more expensive than ordinary textbooks. It is also clear that PI uses less teacher labor once the texts are developed. Given the infinitely reproducible nature of the material, as the use of a particular PI course increases, the cost per student falls, approaching the physical cost of producing the PI textbook plus a place for a student to sit as a limit. PI thus can clearly be less expensive than TI which requires a place for the student to sit, a traditional textbook, and a full time teacher. Another attribute is that it typically takes less time to complete a given body of study utilizing PI than TI. This can be extremely important in terms of efficiency for individuals whose time has value. For adult education, the largest cost of the education is often the time of the "student." Since the results with PI are as good or better and the cost can be much lower than TI, it is clear that this is one technology which is more efficient than TI for those results being measured in the comparisons.

Correspondence Education

Correspondence education (CE) includes a whole set of technologies. In addition to being used alone, CE is sometimes used in combination with IR, ITV, and/or PI. Typically, however, CE relies heavily on student initiative and motivation together with either programmed or other texts. While the success rate in terms of completion of programs begun is fairly low, CE does provide a low cost, convenient way for millions of individuals to acquire education that might not otherwise have been available.[17]

Universities without Walls

A very recent trend in higher education is the whole set of technologies that can be categorized as universities without walls. These vary from televised instruction to syllabi combined with a few days of concentrated classroom activity at ad hoc localities where concentrations of students reside. While some economic data are being developed on those using TV, we know of no economic studies of the latter variety of technology. This type of technology has potential relevance for the secondary level.

Summary

In general, less information is available on the economics of this set of technologies than on the electronic ones. However, a common-sense review suggests that they may be very efficient relative to some of the other technologies. This is an area where a great deal more research is needed.

RESEARCH, EXPERIMENTS, AND INCENTIVES

At various points throughout this paper we mention the need for further research. Often in the same paragraphs we noted reviews, often in the hundreds, of extensive experiments and studies. The problem all too frequently is that insufficient data are collected on the economic variables and controls to make comparisons of efficiency which, of course, require data on both relative benefits and costs. Especially critical for technologies designed for higher and adult education is a specification of student time utilized. As suggested earlier, the time of an individual who already has a high school, college, or even post-graduate degree is often the largest cost of an educational undertaking. Ignoring this cost is done only at the peril of a false conclusion. Thus, the need is not simply for more research. Rather it is for more highly directed research -- research with strong controls and specific objectives clearly presented.

The final point we wish to discuss is the influence of incentives on the use of educational technology. Research and experimentation demonstrating the benefits of any particular technology are not sufficient to achieve widespread utilization of that technology. The results of the research and experimentation have to reach the potential consumer in a form that he will absorb. Potential consumers include both the suppliers and demanders of education: students, teachers, administrators, politicians, and citizens.

For students the need is to demonstrate that a technology is both effective and appealing. The technology that most reduces cost will not succeed if students are "turned off" by it. Benefits to the student such as reduced time or increased convenience are critically important. Thus, it is undoubtedly politic to sacrifice some cost reductions to make a technology more attractive to students, especially at the higher education levels where students have a bit more choice than at the elementary and secondary levels.

As had been indicated above, teachers in the United States are unusually well suited to adjusting to new technology on the one hand and, because of their vested interests and rights, quite able to resist changes on the other hand. Consequently, technologies which ease the burden for teachers are more likely to receive teacher acceptance.

The same points are valid for education administrators as well. However, administrators are particularly sensitive to the risk involved in the adoption of a new technology. Failure of an innovation in terms of insufficient student achievement or inability to implement plans due to resistance of parts of the educational community (teachers, students, parents) can damage an otherwise secure position. Consequently, administrators have to have confidence that a new technology will have a significantly positive impact. A probable or even certain slight improvement is often not worth the effort and risk.

The important connection between research and experimentation and incentives is the dissemination of information. It is quite clear that although thousands of experiments utilizing alternative educational technologies have been performed, most educators, parents and students are unaware of the state of the arts of educational technology. Consequently, they are unable to make rational judgments on the best technology to employ in a given situation. So while a greater portion of the education dollar should undoubtedly go to fully articulated studies of alternative educational technologies, a greater portion of the research dollar should be going to the dissemination of results.

FOOTNOTES

1. For a general presentation of the use of economics in education see Daniel Rogers and Hersch Ruchlin, Economics and education: Principles and applications. (New York, Free Press, 1971).

2. Nevertheless a significant proportion of American youth, perhaps as many as 25%, are leaving schooling dissatisfied with their educational experience -- and rightfully so since they have not learned well the fundamentals of literacy and numeracy.

3. D. Jamison, P. Suppes, and S. Wells. The effectiveness of alternative instructional media - A survey. Review of Educational Research. (Forthcoming) pp. 26-27.

4. G. C. Chu and W. Schramm. Learning from television: What the research says. Washington: National Association of Broadcasters, 1968.

5. R. Duben and R. Hedley. The medium may be related to the message: College instruction by TV. U. Oregon Press, Eugene, 1969.

6. D. W. Stickell. A critical review of the methodology and results of research comparing televised and face-to-face instruction. Ph.D. Thesis, Pennsylvania State University, 1963.

7. Wade Serena. Hagerstown: A pioneer in closed circuit televised instruction. New Educational Media in Action: Case Studies for Planners V. 1. Paris, UNESCO, IIEP, 1967.

8. W. Schramm. Television in American Samoa - 9 years later. Stanford University, Institute for Communication Research, 1973.

9. General Learning Corporation. Cost study of educational media systems and their equipment components. Vols. I and II. Washington: 1968. (ED 024 286)

10. Dean Jamison and Steven Klees. The cost of instructional radio and television for developing countries. Institute for Communications Research, Stanford University, 1973.

11. Jamison, Suppes, and Wells. op. cit., Section VI.

12. John Ball and Dean Jamison. Computer-assisted instruction for dispersed populations: System cost models. Instructional Science, 1, 1973.

13. F. B. Baker. Computer-based instructional management systems: A first look. Review of Education Research, 1971.

14. The historical experience has been that teacher salaries in real terms rise at the rate of per capita GNP, or slightly faster. In a separate paper in this volume R. Morgan, J. Singh, and B. Robinson ("Technology in the Future of Education") review projections of the probable decline in technology costs.

15. Jamison, Suppes, and Wells. *op. cit.*, presents a survey of the literature on this subject.

16. P. C. Lange. *Today's Education.* National Education Association, 1972.

17. McKenzie, Ossian, et al. *Correspondence instruction in the United States.* New York: Carnegie Series in American Education, McGraw-Hill, 1969.

DISCUSSANTS' REMARKS

Representing Chambers of Commerce -

W. Thacher Longstreth, President
Greater Philadelphia Chamber of Commerce
Philadelphia, Pennsylvania

Representing Administrators -

Orlando F. Furno, Assistant Superintendent
Carroll County Public Schools
Westminister, Maryland

W. THACHER LONGSTRETH'S REMARKS

Until fairly recently, I felt that the kind of educational system through which I had passed was the best way of educating everyone. This image of education, which I think so many of us have, is one of the major problems we have to battle today. We have an idealized version of the educational process through which we went, which bears very little resemblance to what really happened. I do not think there is anything we struggle to protect more than the educational system we remember.

I gave you that preamble just to indicate that I have been converted, I have become a believer, and I now oversimplify by feeling that perhaps we do have a system where a certain percentage of kids, the figure 80 percent was mentioned, are going to do well under almost any system. So what you think of as far as those kids are concerned is: Will technology make them do better?

Then you have the other 20 percent, concentrated, as you know, in the lower income areas, who are not doing well under this system and the question is: Will the application of technology make them at least adequate?

That, in turn, leads back to the concepts of business. When technology is brought in, it is usually not based on "will it do it cheaper" but on "will it do it better?" I think that if there is one thing we have learned about the computer and data processing, it is that, no matter what the businessman says, he accepts the fact the most modern technology will not do it cheaper. I know of very few instances where it has been demonstrated that it will do it cheaper per se, but there is a very real hope that it will do it better. And that, of course is when innovation and change come in and when management becomes convinced that the technology is going to do it better.

I am not enough of an economist to get into the question of when does "better" become "cheaper." I realize that happens somewhere along the line, but I am talking now primarily in terms of the initial investment where invariably it costs more.

I think technology occurs more rapidly where it produces either identifiable or dramatic results, as was outlined here on the 5:1 improvement. Identifiable results are, I think, terribly difficult in education, as opposed to identification in the manufacturing world. Technology made tremendous progress in manufacturing primarily because it was readily identifiable. You could see that a machine was producing something much more rapidly and in larger numbers than by the hand labor that had been used previously.

Everything I have heard here indicates that this is extremely difficult to accomplish insofar as education is concerned. I notice that on something that ought to be easy to determine, such as whether or not larger classes are better or worse, there is still a lot of a controversy going on. Although the total number of studies, which is in the several hundreds, would indicate that it does not really make much difference once class size gets past thirty.

That is very difficult for a businessman to comprehend because he looks at the bottom line. As far as the manufacturing processes are concerned, his studies will tell him pretty quickly what is cost/efficient and what is not. So I think the future of technology and its application to the educational system, at least as far as business involvement is concerned, since they have to produce the machines, and political involvement is concerned, since they have to approve the budgets, will depend on your ability in the education world to produce identifiable results on which you are in reasonable agreement.

There is nothing that will turn off someone like myself, either with my business hat or my political hat on, as quickly as when the experts can not agree. I think it is important that before you take your public stand, you have reached some kind of reasonable unanimous decision.

I would like to mention a couple of other points: I have heard a lot of talk about superiority in equipment. I will interpret that as "building the better mousetrap." This does not mean that the world will beat a path to your door, the old axiom notwithstanding. You could develop, let us say, a soap product of absolutely unparalleled performance. Unless you had an awful lot of money and a pretty good distribution system you would never sell enough of that soap to get very rich.

It does not matter how much better a system is or whether or not it was developed through technology, the process of selling it to the user and to the person who puts up the money is something that is going to require a lot more expertise in terms of selling communications than I think is identifiable in the education world at the present time.

Another point that I think is really quite interesting and might be helpful to watch from your standpoint in education is this new concept of word processing. It is fighting some of the same battles that you are. Word processing is just another way of turning out paperwork a little more rapidly and efficiently than we are presently able to do.

The technological improvements made in this country in the last fifty years have come almost exclusively in manufacturing, and yet, the new jobs that are created are about 3:1 non manufacturing jobs. They are in the service field, and we have not had any technical improvements there. Actually we are going downhill. The studies that have been made recently of so-called secretarial help would indicate that it is getting less efficient all the time. But, since it represents a larger and larger percentage of the total amount of work that is done in our society, the big corporations are now suddenly very much aware of it, and they are trying to take steps to improve efficiency.

IBM has devised what it calls word processing, which is a little bit like the old secretarial pool except that it is performed with machinery.

The fact of the matter is that while you're dealing with something that is more efficient, and there is no question about that, you are also dealing with people, who are being displaced, and people who have to change the whole concept of their jobs. Secretaries are now being made administrative assistants and women are now being given opportunities to achieve, which they now find they really do not want after all. There is a tremendous amount of psychological impact above and beyond what actually takes place.

ORLANDO F. FURNO'S REMARKS

I agree with Dr. Sisson that we have to make cost/benefit analyses. I do not agree that we have good cost data, since I have been very much involved in the collection of cost statistics in education. As I indicated previously, part of the problem of a school administrator is that he can not wait for the researcher to make decisions. I have got to make decisions based more on fantasy than on all of the research that you people are proposing.

You also propose that teachers be given a budget. This is not really new. Actually, when we had a colonial system and had one-teacher schoolrooms, the teacher really controlled the budget, controlled the purchasing, and controlled all the processes. But, as our districts grew larger, business people said we should become more efficient. So, we got purchasing divisions and school administrators and superintendents and things of that sort.

We are always faced with buying materials. I am going to talk about the language laboratory because that was quite the rage a few decades ago. Our schools are filled with these broken-down, unrepaired language labs. Hardly a month goes by that some school board member does not remind me of them and asks "why the hell do you educators always buy every gadget that comes along? Don't you care anything about the taxpayers?" They do not go to the teacher or to the researcher and say "why did you put that into our school system?" We have to justify it, so you can see why we are not very enthusiastic.

You also went into accountability and the benefits of the free market mechanism for developing cost/benefit analysis. I think this would very rapidly create top-level school administration vacancies. I am not going to agree that this would not be a good thing, but normal day-to-day factors are already operating quite effectively to have administrators change jobs. We really do not need any help in this area.

You also alluded to segments of teachers being replaced through sophisticated retrieval systems. I can recall over a decade ago when I was making a pitch to our school board and board of estimates on how much money we would save if we updated our computer system. It would mean fewer people, etc. I just reviewed the figures; costs escalated $21.5 million and the staff went to over a hundred. It was a good thing I got out of that system.

I am pleased to see that the author recognizes a valid goal of the educational system, that of providing employment. I think it is a very important factor of education. It might not be efficient. It might not be worthy of doing cost/benefit studies on, and so forth. But the fact of the matter is that this is an important goal of our schools, and we are continually pressured by our state legislatures, mayors, councilmen, etc., to continually employ people, not at the professional level, but at other levels.

You also said in your paper that this well-designed CAI system can provide arithmetic drill and practice at $1.15 per contact hour. That would amount to about $57.50 per pupil per year. In our 1973-1974 budget we are going to spend about $48 per pupil for all instructional materials, and I invite you to come to our school district to find that $30 per pupil that you said was so easy to find. I would like you to help us.

In addition, you deal with technology decisions in school districts, and you imply that we have to get good procedures for developing costs. That is very, very true. I do not think you can do very good cost/benefits based upon the present data collection in school systems. We simply lack the staff and we lack the monies to purchase the staff and develop the system to get good cost data.

Now let me comment upon the paper by Daniel Rogers and Dean Jamison.

I would like to comment on some of the factors that I think economists really should look to. When I was in a very, very urban district and we constructed a school, I did not have to worry about things such as the development of a water system or a sewer system. In my present job, when we build a school I not only have to worry about the construction of the school, but also water and sewer systems. We just cannot drop our effluents in any old stream that happens to pass by, because it might be another city's water system. Consequently, we are continually interacting with many other agencies. I think this is very important because it takes away from our budget a great deal of our time and a great amount of our dollar resources.

Ecology is also going to have a great impact. For example, we are involved right now in converting several of our schools from coal furnaces. And not only that, we have to convert our oil from Number Two to Number Five, into low sulfur content, and this is quite an expensive process. So here we see costs associated with schools which I cannot believe are true educational costs.

MANAGEMENT FACTORS

MANAGEMENT MODELS AND INSTRUCTIONAL PRODUCTIVITY

by

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INTRODUCTION

Economists frequently make a distinction between the **base** of a social system and the **superstructure** which evolves in support of the base. The base may be, as it is in education, a fundamental premise that defines operational relationships and invests authority. The superstructure is the pattern of institutions, laws, organizations, traditions and habits that support, reinforce and maintain the base. If new developments imply a new base for the system, the superstructure of the existing base acts as the major deterrent to change. When this type of power struggle arises, typical diffusion and adoption practices are of limited use because they are designed to bring about change **within a given and accepted set of fundamental relationships.**

When formal education evolved in the United States, assurances of quality instruction had to be obtained by relying on the credentials of the person responsible for instruction. For example, the classic Carnegie Unit is defined in terms of hours spent in a classroom with a teacher who has taken a specified number of college credits (defined in a similar manner) in an accredited institution. In other words, the fundamental premise -- the base -- of education is that responsibility and authority for instruction are vested in the person in face-to-face contact with students in a classroom. A superstructure has developed over the years to maintain and support this fundamental premise.

Technologically-based instruction poses a threat to the base of our present system, and the more comprehensive the technology, the greater the threat. Television and programmed instruction are cases in point. In a report to the 1970 convention of the Association for Educational Communications and Technology (AECT), Eleanor Godfrey of the Bureau of Social Science Research cited evidence that teacher resistance to television as direct instruction is causing a decline in use even where that medium has been effective. Because programmed instruction not only purports to be a course of study (as a textbook is) but also claims to complete the instructional act, it disturbs the symbiotic relationship that has developed between teacher and textbook. The teacher may rely heavily on the scope and sequence of the text but feels secure in the knowledge that he still must "dig the instructional ditch." His place in this scheme of things is secure. Therefore, "modular" and remedial programmed instruction may be acceptable, but not completely programmed courses. This last point is an example of why cost-effectiveness studies **accepting the present base** are futile: technology is an additive cost.

Many more instances of resistance to technologically-based instruction could be cited, but the main point is that management models for cost-effective systems must be based on a different fundamental premise, and we must take into consideration how the present superstructure possibly prevents alternative modes of instruction from competing as options for the student. The wide ranges of instructional choices that technology can make available to curriculum administrators and students are prevented from effectively competing in the educational market place by a superstructure geared to an outmoded fundamental premise.

We do not appreciate the extent to which the superstructure of education inhibits educational technology. Management models that do not take this factor into consideration will likely fail.

The strategy of looking at technology and traditional educational practice as irreconcilable helps throw certain key problems into sharper focus.

THE BAUMOL CRUNCH

Professor Baumol of Princeton University has contended for some years that a number of operations in the public sector of the economy will be subject to pressures to increase productivity (Farmer, 1970). He has maintained that there is a limit to the tolerance of the increasingly more productive segments of society toward those that are less productive. While this has always been true, relatively recent dramatic increases in productivity have thrust the issue into prominence -- so much so that the pressures on the non-productive areas have been given the sobriquet, the Baumol Crunch.

The Baumol Crunch is manifested both through overt attitudinal expressions on the part of the productive sector and through inherent systemic relationships. An example of the former is the usual Chamber of Commerce member's belligerent query, "Why can't they run the schools like a business? We've developed more efficient ways of using resources; why can't the schools?"

However, the systemic relationships are the more critical. If the cost of doing business goes up, and the productivity of the institution stays the same, the Baumol Crunch will start to operate. The only alternatives for an institution like the schools are to charge more for services (in the form of increased taxes) or to seek other sources of funds.

Starting in 1958, the Federal government became a large enough source of funds to soften the Crunch. However, sharp curtailment of Federal monies in the last few years has revealed the extent to which local funds have been out of balance with real costs.

Even in his more pessimistic moments, Baumol did not entertain the unusual situation that now pertains to the schools -- costs going up and productivity going down. Every time a teacher negotiating group forces a change in pupil-teacher ratios, while at the same time negotiating higher salaries, the Crunch is accelerated. For example, a few years ago, the Los Angeles schools had bond issues defeated four straight years, causing a severe financial squeeze. The teachers struck, but finally realizing that the financial situation of the Los Angeles schools prohibited granting their demands, the teachers rejected the offered compromise raise with the request that the money be used to reduce the teacher-pupil ratio -- a stipulation that could only exacerbate the condition the following year! When the current sharp increase in prices influences the next wave of contract negotiations, a collision course between taxpayer revolt, teacher demands and instructional productivity may become unavoidable.

While Baumol's argument was directed at public agencies in general, the schools are a particularly good fit to his conditions. In the private sector, if a company becomes marginal because it cannot increase productivity in the face of rising costs, it closes its doors, or changes product lines (unless, of course, Federal intervention as in the case of Lockheed rescues it). A company that **does** increase productivity is rewarded. The public schools have no way of dropping the marginal producer except during the probationary period, and even then marginal productivity is probably not an important criterion. Similarly, no formal method exists to reward increased productivity. (For these reasons, diffusion and adoption models from sectors of the economy, such as agriculture, that can drop out the marginal producer and reward productivity, are inapplicable in education.) Increasing productivity, or cost-effectiveness, would seem to be the only way out. But to do so will require management models that permit increased productivity to occur.

MANAGEMENT MODELS

The main purpose of this paper is not to explore specific management models in reference to cost-effectiveness. My position is that unless the basic decision-making process is attended to, management models will tend to operate within what Thomas Kuhn (1962) refers to as "normal science." If the model accepts the paridigm or basic decision-making structure of the system, then it will simply reinforce the basic paradigm by making it seem more efficient. **My premise is that the present basic decision-making structure is inherently limiting in reference to cost-effectiveness of the system and must be changed before applying a management model.**

Years ago, the semanticists convinced us that the word is not the object, and the map is not the territory, but apparently failed to convince us that the model is not the process. Those of us who have become preoccupied with drawing flow charts of processes, or organizational structures, or of a mix of both, tend to become convinced that those little boxes are people, and when we move the little boxes, the people really move, and when we build in decision points, decisions are really made there. We become convinced, in other words, that our elaborate conjectures are reality.

This is what I am trying to avoid. Instead I will identify certain critical parts of the superstructure of education that must be dealt with before any management model can be devised. As mentioned earlier, the kinds of governing laws, regulations and policies that strengthen present educational practice do not facilitate institutionalization of technologically-based instructional systems. In order to establish an environment that encourages technological solutions to instructional problems, changes in, or at least suspension of certain aspects of the governing structure are essential. If those aspects of the superstructure can be dealt with, then management models should be more readily identifiable and their operating details a matter of try-out and revision.

FISCAL AND BUDGETARY MANAGEMENT

We do not appreciate the extent to which the regulations involving how school districts receive and allocate funds force them to make artificial distinctions between modes of instruction. An economist would say that the financial structure of the schools "biases the mode of production" of the enterprise; it tends to push the schools in the direction of pivoting instruction around the person physically present in the classroom, tending to make educational technology a peripheral and marginal part of the process. The following will serve to illustrate what I mean. This example was constructed to raise a number of problems, and is extreme only in that I collapsed a number of separate real incidents into one case.

Suppose, in a given state, A city district wants to revise its high school physics curriculum. The district discovers that Harvey White is reputed to be an outstanding teacher as well as scholar and hires him to teach physics for one year (as Pittsburgh did some years ago). Now, if White teaches the course in one of A district's high schools, his salary is charged to instruction and state aid is forthcoming (provided, of course, the State Department of Education is willing to issue him a temporary certificate). The district, deciding that it would be wasteful to use White in only one high school, asks him to teach the course by television. In this case, his salary is still charged to instructional salaries, but in some states, state aid for his efforts may be in doubt because of a narrow definition of "teacher." However, in all likelihood the district will manage to get around that one. But then the district decides that one year of White will not be sufficient and videotapes the televised series of programs. The cost of the tapes and other production costs are charged to supplies. When the videotapes are used the following year, state aid will not be forthcoming even though White is still teaching the course! In other words, state aid, when based on a certificated teacher-pupil ratio, is forthcoming if he is physically present in the classroom (or at least in the district) but not if he is instructing through a recorded form of technology.

Nor is the state in a position to issue a certificate to a bunch of videotapes. As mentioned in the introduction, assurances of quality are sought in the credentials of the instructor, not in the instruction itself. Harvey White was chosen deliberately because about 15 years ago his televised course was filmed and districts ran into the problems described.

The ironic aspect of this situation is that A will receive state aid for any certificated teachers used as proctors in the classrooms receiving the videotaped instruction, even though they are not involved instructionally. The state aid formula in Indiana not only cuts off state aid for teachers instructing through technology, but provides state aid for certificated teachers, in ratio with the required number of students, even though those teachers have no instructional responsibility.

The final irony is that if any one of the certificated teachers acting as proctors decides to turn off the television set and teach the class himself, the local teacher association will defend his action even though the program objective of the district is violated. Another way of putting this is that authority resides in the certificated teacher physically present in the classroom, not in the teacher assigned instructional responsibility.

This is what is meant by biasing the mode of production. Technologically-based instruction is obviously not facilitated; classroom teacher-based instruction (**aided** by technology on an additive basis) is.

Because technologically-based instruction comes in forms that are categorized as supplies and equipment, present economic pressures force them into the expendable category. The percentage of school district budgets devoted to salaries is increasing, leaving less available for supplies and equipment. What is needed is a management model that permits allocation of district funds to instruments of instruction based on measurable units of student achievement, regardless of the form in which they are incorporated. This brings us to state aid.

The extent to which schools depend on state aid varies greatly, but in all cases the percentage is large enough to affect decisions related to personnel. It is commonly believed that the major share of state aid is based solely on a per pupil basis. In actuality, it is frequently based on a ratio of certificated teachers to a specified number of students. The definition of "teacher" varies considerably also. All of these non-relevant stipulations should be eliminated in order to permit state aid to be allocated strictly on the basis of students. Any funded demonstration projects should either take place in a state where aid is allocated by student count only, or in a state willing to suspend restrictive regulations for experimental purposes.

The California code that applies state aid to two-year colleges is one of the best models now on the books. Over a period of years, the code was changed from one that granted state aid only for students directly under the supervision of a certificated teacher to one that grants aid for students under the **indirect** supervision of a certificated teacher. The code was changed to accommodate instructional management models such as audio-tutorial methods, televised instruction, etc.

Even though the Supreme Court did not concur with the Rodriguez decision, many state supreme courts' rulings, following Sorrano and Rodriguez, will result in higher levels of state support for schools, making the question of how state aid is distributed even more crucial. To my knowledge, restrictive state aid formulas have never been tried in court. A court case came very close in the Gary, Indiana, performance contract battle several years ago. A very real question arose as to whether state aid could be used to support performance contracts because of the restrictive nature of the formula. However, the issue was skirted by the State Department of Public Instruction in bringing pressure to bear on Gary in favor of issues such as adoption of state texts, adherence to state curricula, etc. (Wilson, 1973).

Somewhere along the line, a friend of the court case may have to be instituted in a state with a cost-effectiveness demonstration project in order to clear the way for continuance of the project when the Federal funds phase out. It is obvious that the management model of any cost-effectiveness project cannot be allowed to be vitiated by state regulations that go back into effect when the experimental funding is over. The compatability of state laws and regulations should be looked at very carefully before any demonstration projects are placed in any state.

Very possibly, restraint of trade arguments might be advanced in contesting state aid restrictions. For example, if a private company is denied a performance contract on the grounds that the district would lose state aid as a result, the company could sue on the grounds that the state aid formula is in restraint of trade. The restraint of trade issue was involved in the case of Marjorie Webster Junior College vs. The Middle Atlantic States Accrediting Association, but the Supreme Court reversed the lower courts by ruling in favor of the accrediting association, leaving the question unanswered.

FUNCTION OF FEDERAL AID -- AND AFTER

In general, the basic fiscal regulations governing schools inhibit the schools from using the system that industry does to get large-scale projects underway. The schools are not geared to raising "front-end" or "start-up" money to finance the expensive planning and tooling-up stages necessary for cost-effective production. Nor can they then amortize those costs over a period of years, making the initial investment worthwhile. (Nor do they accept the necessity to institutionalize the product of front-end planning -- this point will be made later.)

A mechanism exists for schools to go into the open market for money for building projects but not for curricular and instructional development. This could be the function of Federal money: to be the market place for financing the demonstration projects contemplated by the planners of this conference, but with one critical stipulation.

Before a school district is awarded a cost-effectiveness demonstration grant, a detailed plan must be presented showing: 1) how the products of the planning stage will be institutionalized; 2) how the continuing operation of the project can be carried on with normal sources of revenue; and 3) how the project will or will not be affected by state and local regulations and agencies when Federal participation is phased out.

I have seen too many projects funded by foundation and Federal money disappear with the termination of funding because the schools involved made no fundamental changes in their usual operating style and, in effect, used the funding to create artificially inflated situations. This is acceptable if the purpose of the project is simply to develop an innovation, but intolerable where the continuance of the project under usual conditions is the raison d'etre of the grant.

Nor do schools often think through the fiscal ramifications of an experimental project if it is successful. In other words, schools do not often gear up for success. For example, a large school district may find it possible to spring loose a hundred thousand dollars or so to set up an experimental CAI program to serve a select group of schools or classrooms. For the usual reasons, the CAI is, in actuality, an additional cost to the standard classroom unit. The experiment is successful, and all classroom units now demand the CAI service. Then the district has to admit that what was possible as a small experimental situation is impossible on a district-wide basis because it cannot afford to provide the service over and above an accepted classroom unit cost. It would be possible if the CAI was able to **share** the unit cost but the original project was not structured on that basis.

As mentioned before, no demonstration grant should be awarded if the applicant cannot show how the successful project would be viable throughout the district.

CURRICULAR AND INSTRUCTIONAL PLANNING MANAGEMENT

The structure of traditional curricular and instructional planning and implementation assumes that final decision-making in regard to specific instructional acts takes place in the classroom by the person in face-to-face contact with students. Curricular planning stops short of specifying and **developing** actual instruction; or if it does, it assumes that teachers at the time of interface may or may not employ the developed products. It is essentially a linear decision-making process. In terms of technological development, it corresponds to a craft pattern where the skill of artisans in their **use** of tools is emphasized. In this context, technology is additive, serving to **aid the teacher** when the teacher deems it appropriate.

The nature of curricular and instructional planning, based on the employment of highly developed technologies of instruction, is quite different. As technology becomes more sophisticated, it incorporates more and more operational actions into the **design** stages, reducing the necessity for ad hoc decisions at the point of use. In sophisticated technology, increases in productivity **and variety of product** are much more likely in a system that stresses design of comprehensive control systems than in one that relies on successive operation of discrete tools. Instructional technology fits this pattern; traditional instructional planning does not. This means that the linear, discrete decision-making steps typical of traditional instructional planning are replaced by a systems approach to instruction by which interdisciplinary teams cooperatively design curriculum **and** instruction in parallel operations. In industry, this leads to decision-making by what the economist Galbraith (1967) refers to as the "technostructure" -- a collection of specialists engaged in comprehensive, collaborative planning, who then carry out their respective operational assignments concomitantly. The critical point in reference to instructional management is that operational assignments are specified in the planning process, and while considerable latitude may be permitted in how an operation is carried out, any changes in the basic parameters must be referred back to the planning stage because of repercussions on the other components of the system.

These planning teams would operate primarily on the district level (as do traditional curriculum planning groups) with counterparts on the appropriate building levels. The teams would consist of curriculum specialists, content or grade level specialists (who probably would function as teachers in certain operational phases), instructional developers, instructional product designers, evaluators, students and any others that would be needed. These teams would be responsible for both developing instructional systems and examining, approving, and, if necessary, modifying instructional systems produced outside the school district.

Programmed instruction, televised instruction and audio-tutorial instruction are examples of technologies of instruction that combine curricular and instructional planning and implementation. The IPI program, the University of Akron (or the country of Niger), and the Postlethwait program at Purdue are specific examples that have operationalized each of those technologies successfully. The audio-tutorial approach, which can be considered as programming applied to the language laboratory, has struck a responsive chord in academic circles because it bridges two traditional activities -- lab and lecture -- in a more effective way. Perhaps it is appropriate to mention here that, from the broad view of educational technology, whether any particular course is taught entirely by programmed instruction, television, audio-tutorial methods, or any other comprehensive technology of instruction is less important than the fact that an entire course **can be** undertaken by technologically-based instruction. The decision to use one or another (or a mixture as in the case of the Open University) may be based more on the particular requirements of interface, delivery and other aspects of the environment than on a question of relative effectiveness -- assuming that whatever presentation and delivery forms are used, they are brought to maximum effectiveness by try-out and revision (formative evaluation).

From a cost-effectiveness point of view, it must be emphasized that the type of planning discussed here is as necessary in a system that provides a variety of instructional components from which a student may assemble his own course of study, as it is in a system that prescribes instruction. It must also be emphasized that this type of planning is essential in order to "recover" teacher time replaced by technology -- certainly a critical factor in cost-effectiveness.

Any demonstration project must have a management model that provides for curricular and instructional planning procedures as outlined above **and** assures translating the integrity of that planning into operation.

INSTRUCTIONAL MANAGEMENT

The two most critical areas that a management model must deal with are: 1) maintaining the integrity of the planning and development stages through the implementation stages; and 2) institutionalizing the products of curricular and instructional design. The histories of the large-scale science curricular innovations such as Physical Science Study Committee (PSSC) and Biological Sciences Curriculum Study (BSCS) document frustration with this point. Marsh (1964), in his history of PSSC, ruefully comments that while physics teachers admittedly learned much from the PSSC materials, less than half used those materials in their own classrooms. BSCS frustration over this problem led to their proposal of a different diffusion model for a new life science course (BSCS, 1969). The new model was their hope of maintaining the integrity of the program when introduced in the individual schools. The disseminators of **Man, A Course of Study,** are attempting to maintain the integrity of the package by refusing to sell pieces of it, and by rigorous in-service training requirements.

Many projects carried on within the traditional instructional process fail because teachers will make commitments at the planning or strategy level that, for a variety of reasons, they do not carry out on the operational, or tactical level. We have all witnessed this phenomenon, which is, in my opinion, a major contributing factor to Goodlad's (1970) discouraging report, **Behind the Classroom Door.** The solution would seem to be to arrange the environment in as effective a way as possible to encourage the concept of shared responsibility between development and implementation groups implicit in the previous section. Churchill once remarked that first we shape our buildings and then our buildings shape us. The systems literature holds many examples of how changes in the environment (used broadly) change behavior. Sociologists and anthropologists, particularly Edward T. Hall, have documented many instances of the same phenomenon. This point is important to keep in mind because in the comments to follow I am not criticizing people but, rather, recognizing that they respond to the forces exerted by environmental conditions and requirements.

The classroom is the territory of the teacher, an inevitable manifestation of the base of the traditional educational system. The authority of the teacher **within that context** is based on being given a classroom (in the form of grade level or subject) and assigning students to that classroom. If students were **never** assigned to specific teachers, the nature of professional activity would change as the base of authority changed. The open school, the non-graded school and IPI are moves in this direction.

Let me pick up the other end of the stick and set up a situation that might help illustrate what I mean. Suppose it was possible for students to get all the information and instruction they need at the end of a computer terminal, and, perhaps more importantly, could be evaluated completely at the same computer terminal. What would happen to the character of professional activity? It is always hazardous to attempt to predict the dynamics of a new environmental arrangement from the viewpoint of the present one, but surely one result would be a shift of professional personnel to designing computer programs, and a possible change of what were classroom teachers to floating consulting roles, with a corresponding increase in paraprofessionals directly contacting students. We would also abandon the dogma that the person who is in most frequent physical contact with the student is the best judge of what he needs and how he learns, and a different kind of relationship would evolve between and among program design teams, consulting teachers, paraprofessionals and students. One manifestation would be a sharing of responsibility for student progress, each participant concentrating on those functions that best fulfill the various roles.

I hope this little scenario will serve to orient you toward the remarks to follow. Management models designed to foster cost-effectiveness through technology must facilitate an environment that moves away from the traditional territorial concept inherent in the systems approach. Contrary to what many people think, in a systems design, decision-making and responsibility are shared, not expropriated. Some facilitating changes in this direction that a management model must incorporate are listed below.

1) **Don't challenge the authority of the teacher in his own territory.**

One of the fatal mistakes schools using technology such as television and filmed courses make is to force the teacher to share his platform with another authority. The teacher is asked to maintain order while someone else takes over **his** class. It is hardly surprising that teachers resent the non-person role (to use Goffman's term), as reported, for example, in the Wisconsin experiment in using the Harvey White physics course on file (Scott, 1960). Paraprofessionals should be used for this purpose or the environment changed so that students interface with media in a location other than the classroom.

One of the contributing factors to the success of some individually-paced instructional programs such as IPI is that the environmental arrangement minimizes the challenge to the teacher.

2) **Use interface forms that students, not teachers, use.**

The trend toward cartridges and cassettes should be encouraged because it will tend to weaken the classroom as a territory in the same way that the paperback has tended to break the monopoly of the textbook. Technology designed for group presentation reinforces the traditional pattern (as does the textbook) unless the environment is arranged as stated previously. As media forms become more portable and students can take information and instruction wherever they go, the classroom walls will start to erode, and different options can occur. For example, if BSCS materials were **all** in these new forms, the student could choose which version to go through, based on his interests and aptitudes, and not have to accept the choice of the teacher in whose class he happened to be.

3) **Differentiated staffing.**

Differentiated staffing is well known but still controversial. The NEA is schizophrenic on the point; the AFT is simply opposed. Both groups (or the merged group) will have to accept differentiated staffing as a more cost-effective way of fitting the person to the task. Teachers are concerned that differentiation may mean reduction of professional personnel. They may be right, but this is a reality they will have to face. In Banneker School, Gary, Indiana, the number of paraprofessionals increased and the number of professionals decreased during the performance contracting period.

4) **Evaluation of students, a "public" process.**

Traditionally, evaluation is between teacher and student, but when instructional planning and execution are a collaborative process, then evaluation of student progress must be collaborative. If the various evaluation instruments are an accurate reflection of **all** the products of curricular and instructional planning, there is far greater likelihood that **all** components of the instructional system will be used.

5) **Accountability.**

Closely related to the above is the principle that if instructional efforts are collaborative, then the teachers can be held accountable only for the instructional role assigned to them by the planning process. In other words, they can only be held accountable for those aspects of student performance for which they are given responsibility. Teachers will be more willing to participate in the type of instructional management outlined under this condition.

6) **Logistical management.**

In the normal course of events, we do not appreciate the extent to which instructional control is surrendered to administrative convenience. By turning over to teachers all administrative chores connected with instruction (e.g., proctoring), the principal of a building may relinquish any instructional control he may wish to exercise. If he recognizes and accepts certain administrative responsibilities, he is in a better position to influence the arrangement of the environment. While the planning team may devise alternative approaches to instruction, it is obviously not in a position to arrange the local environment. The team needs a surrogate to act on its behalf. In a school, the teacher is usually the surrogate, but as mentioned before, he does not want to limit himself to that task. The administrative staff of the school must accept the surrogate role and manage the logistical aspects of whatever the design may call for. There are a number of management models that can help, such as modular scheduling. Certain computer managed instruction projects would also provide useful models.

By "institutionalization," I mean the continuance of all elements of the project, regardless of a temporary cast of characters. Two important stipulations must be built into the management model: 1) new personnel must agree to work within the framework of the project and accept its basic premises; and 2) decisions to accept and continue (or discontinue) any of the products of the system must be based on student performance data.

In regard to the first point, Oakland Community College's innovative program suffered because new faculty were not hired with the explicit understanding of the way in which the institution carried on its instructional program. The management model must provide for the necessary in-service program to train new people.

In regard to the second point, it is critical that adoption of all components of the system is based on data obtained from field trials with samples of the target audience. Just as important, once a product has been accepted on the basis of student performance data, it cannot be replaced without hard data to back up the replacement. Decisions cannot be based on personal preferences unsubstantiated by data. Unfortunately, virtually all evaluations of instructional materials are now based on "expert" opinion, not student performance data. One of the disenchanting experiences of the programmed instruction movement was educators' disregard of field test data when they were available.

ROLE RESTRUCTURING

Much has been made in professional literature about the necessity of restructuring the role of the teacher because of technological developments. I have touched on this point before. Any project should have a well developed in-service program for this purpose.

However, to me, much more critical is the lesser known necessary restructuring of the administrative staff. They are the key to the success of any comprehensive project. I have implied this in several preceding sections. But administrators are still under the impression that all these new developments are of concern primarily to teachers and not to them. Even when administrators feel they should be concerned, they are reluctant to exercise a role that is professionally uncomfortable. For example, during the performance contract in Banneker School, BRL had to appoint an administrator specifically to manage the project and to exercise the decision-making authority the principal had but was, apparently, reluctant to use. So Banneker had two principals: the official one that acted in the usual hold-the-lid-on capacity, and the unofficial one that functioned as instructional leader.

It probably would be best to recognize this situation and provide for an assistant principal of instructional systems within any management model. In this way, someone with sufficient administrative authority to structure the school environment would be in charge. In secondary schools, department heads would function as intermediate points between assistant principal and teachers.

The central staff of the district must be prepared to take a much more active part in instructional planning and design. Curriculum personnel, in particular, are frequently not prepared for the type of direct instructional involvement required. One of the important requirements of a management model must be evidence of an understanding of, and a readiness for, the kind of hard-nosed involvement by the central staff in the design and execution of the system.

CERTIFICATION AND ACCREDITATION

The June, 1972, issue of **Nation's Schools** carried this item:

> ...Addison Trail High School in Illinois conducted a typing class using a line teacher with a class in one room and the same teacher over TV for another class in another

> room supervised by a paraprofessional. The local teachers' union (an AFT affiliate) objected and won a ruling prohibiting the TV class. The legal staff of the state department of education said the grounds for ending the TV teaching were that, according to an old Illinois law, a paraprofessional cannot supervise students unless he or she is under the **immediate supervision** of a certificated professional.

The base of the system is using the superstructure to protect itself.

Any attempts to design cost-effective projects must take into consideration potential certification and accreditation problems. The Illinois case is not an isolated example. The Appalachia Regional Laboratory ran into the same problem in West Virginia, with the same results. In certain states, between certification requirements and state aid formulas, demonstration projects may be impossible, or self-defeating. A thorough investigation of state laws in these matters would seem appropriate, not only because projects would be best placed in states where flexibility exists, but also because final reports of such projects (and of OE and NIE) should make reference to required changes in state laws if cost-effective programs are to be facilitated. At that time, the cooperation of the Education Commission of the States will be essential.

While accreditation practices are a problem in certain areas, and certainly should be explored, the accrediting agencies have relented in varying degrees from the old Carnegie Unit. The North Central Association of Secondary Schools and Colleges has probably progressed more than the others in this regard. However, from personal experience, I know that accreditation teams are more hidebound than the Association. Of course, elementary, middle, and, in most states, junior high schools are not affected. Demonstration projects in junior colleges do face the accreditation problem.

TEACHER ASSOCIATIONS

The organized teaching profession seems to be reliving the history of organized labor, and at this point seems to be about where organized labor was fifty years ago. It seems to be taking a craft union approach, relying on the teaching equivalent of standardizing the four-inch paint brush for protection. Contracts that require strict adherence, classroom by classroom, to set pupil-teacher ratios, make cost-effectiveness impossible. They simply reinforce certification and state aid restrictions. Paul Dawson's (1971) research on the attitude of teacher negotiators toward media reveals a more than casual Luddite approach.

Eventually, the teaching profession will have to come to terms with technology and realize that increased productivity is the best way to real salary increases. It is interesting to note that in several places where teachers have taken out performance contracts, they increase the number of students they are responsible for and they rely more heavily on technologies of instruction. Perhaps these seemingly insignificant instances will point the way to teacher acceptance of productivity increments.

Perhaps the eventual merger of NEA and AFT (as reported in the newspapers after the recent NEA Convention), will hasten a rapprochement between teachers and technology. At least one group will not find it necessary to "out-union" the other group, and experimental situations can be agreed to without risking vulnerability.

However, for the practical present, projects must come to terms with whatever teacher associations are in the districts in consideration. The best demonstration spots might be medium-sized districts operating under flexible state laws with no history of labor problems. But, if successful, the real benefits should be such that the teachers would become advocates. There would be little point in developing cost-effective projects that offer no rewards for the participants.

SYSTEMATIZING FOR STUDENT OPTIONS

I received this assignment shortly before leaving for vacation in southwestern Colorado. As I gazed at the Rockies from our camp, I could not reconcile my assignment with my own choice of untechnologized surroundings. Then the obvious dawned on me. My choice of location would have been impossible without technology. Just as technology served my purposes, so should technology serve the students' purposes. Applying systems technology to instruments of instruction does not mean systematizing the student as well. The objective should always remain to give him a range of choices. Any management model should take into consideration that students accept technology that helps them achieve their ends, but resent our use of technology that serves only our ends. Mechanization of students is not inherent in technology but, rather, in the uses to which it is put.

In this context, open schools might very well lend themselves to cost-effectiveness studies. The concept of the open school certainly makes it technologically dependent -- even though many people assigned to them do not understand that and mentally put walls back in. However, for a cost-effectiveness study, a management model that keeps effective track of the progress of all students is essential. Monitoring and evaluation systems are vital to keep many students from disappearing into the background or losing sight of objectives. A number of open school plans are deficient in this respect. We have taken teacher evaluation of student performance for granted for so long that when we shift to a plan that makes teacher evaluation difficult, we fail to provide an effective substitute. A few years ago, Evanston (Illinois) High School reported that those students who did poorly under the old system did even more poorly under modular scheduling. The acknowledged reason was a failure to devise a collaborative monitoring and evaluation system. A good CMI model should be employed for this purpose in several projects.

CONCLUSION

The obstacles to real cost-effectiveness studies through use of technology are formidable. The present system exerts strong pressure to maintain a floor under the basic unit of cost -- a fixed number of teachers for a given number of students. I am told that in some cities, the percentage of the budget devoted to salaries is approaching 90 percent. Taxpayers probably feel that even if the total budget is increased, the labor intensive nature of education will tend to keep the percentage high. This is part of the Baumol Crunch.

Given the extreme labor intensive situation of education, a district can not make any great cost-effective gains by, say, not cutting the lawn every other week. There are really two choices, it seems to me: make the system less labor intensive, or, from one source or another, increase **substantially** the amount of money allocated to education.

Perhaps increasing productivity through technology can be accomplished only with institutions created on a technological base, such as the Open University in England; or by letting private industry respond to new ways of awarding degrees, as in the case of Empire State College, Edison State College, etc. But new institutions were not our charge.

A final caveat. New technologies, and particularly systems based on new technologies, are not "proven" or "disproven" by one-shot experiments that may be measuring unimportant comparative features. For example, if educational researchers had been around at the time of Gutenberg, they would have conducted a study comparing learning from print and learning from illuminated manuscripts. They would have found no significant difference, urged the book be scrapped, and would have totally ignored the potential in the **real** difference between the two. The technology of print broke the monopoly of the church on knowledge. But to do so it needed time, faith and an environment that tolerated its slow early growth and then facilitated its rapid expansion. In addition, longitudinal studies are necessary to overcome the John Henry Effect (Heinrich, 1970, p. 162): the tendency of control group teachers to give maximum rather than typical performance to "beat that steam drill down." In education, we need to create an environment that finds the products of technology both useful and desirable. Without that environment, the products of educational technology will remain the objects of luxury.

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DISCUSSANTS' REMARKS

Representing Teachers -

Eleanor Lonesome, Curriculum Writer
Instructional Computer Center
Philadelphia, Pennsylvania

Representing State Departments -

Joseph DiStefano, Director
Bureau of Instructional Technology
New Jersey Department of Education
Trenton, New Jersey

ELEANOR LONESOME'S REMARKS

As I said yesterday, I think teachers in practice, teachers who are already teaching, are open to technological innovations because they are the ones who understand that they need the help. They are not too concerned about the money the way administrators are. They are just concerned that they will be able to get whatever they need to do the job in the classroom.

In regard to getting support in general for whatever kinds of innovations you are going to have, it is my feeling that our society is not supporting technology-based instruction in order to replace teacher-based instruction, or even to have it exist beside teacher-based instruction. Society has not established this as a goal. There has not been a consensus that this is the direction in which we should move.

I think it is as true here as it is in personal experience. If you do not set a new goal for yourself you do not move. You tend to support what you are doing as a satisfactory level of achievement for yourself at that time. I do not doubt that all of us here have reached those kinds of plateaus in life, but then hopefully before too much time goes by we decide that there is more that we can do, and we set a new goal and begin to make provisions to move toward that goal.

Our society set the goal to provide formal education for all children in the nation, and the consensus was that responsibility and authority for instruction would be vested in a person who was trained to teach.

That goal was provided, supported, and reached to what was considered a satisfactory level. Some mini-goals have been set and supported through the years, but basically society reached a plateau where education was concerned. To make any drastic move from this teacher-based system, I think a new goal must be set and the consensus must be found for it before it will be supported from the top down.

I do not think we really want a goal to be set to replace teacher-based education with technology-based instruction because that is too limiting. The real need is for society to set the goal to provide quality education for every child. If we can reach a consensus on that, then we will be raising the priority of education and begin to support whatever new approaches are necessary to reach the goal.

That is too simplistic, I guess, but what I am getting at is that we need a mandate from society before we can be successful in changing or significantly altering the base of one of its major institutions. How to get that mandate is the problem. How will we ever go about changing national goals? I do not know. What was the evolution of the goal we set to put the man on the moon?

Going back to those two success stories that were told near the end of the session last night, both of those were examples of people sitting down and reaching a consensus about exactly what they wanted to do. Each person was committed to his role because he helped define it and understood his place in the total plan. A goal was set. They said, "we will use these materials effectively and to do that we will have to do this and this and this." There was not much room for deviation.

It is something like coming to a decision by the technostructure that Dr. Heinich defines as "a collection of specialists engaged in comprehensive, collaborative planning, who then carry out their respective operational assignments concomitantly." It is letting people know what they should do and what exactly they have to do to get there.

Touching on another area: a principal does not have to worry about grievances coming from a teachers' union when he manages to get his staff to commit itself to a school goal. If a consensus is reached, where everyone feels he has a responsible role in the plan, normal complaints about extra time spent in planning tend to disappear. Petty concerns are absorbed by this total commitment to the larger goal.

In addition, incompetent teachers are pressured out because they cannot keep up and their peers tend to make them leave the scene.

What I think leaders have to do is this: Let leaders emerge who will advance an alternative plan to teacher-based instruction and seek until they find that consensus that will get all of the parts of the superstructure together and work toward that goal. If the decision is, as I have said, that we have to rearrange the whole structure and some teachers have to go, then that is what should be done. But you cannot do that until the consensus is reached. As it was pointed out, if we can not reach a consensus how can we expect anybody outside to support us -- the government, the parents, the children or anybody?

JOSEPH L. DI STEFANO'S REMARKS

My first reaction to Dr. Heinich's paper was that he was advocating a student revolution in which we discard the child labor laws; abolish compulsory education; promote student unions; design a strike for better education; launch public relations campaigns promoting the benefits of cost/effective education, accountability, and educational technology; point out the inequities in education from one school to another, one town to another, one county to another, and one state to another; push for community action where students can interact with adults at-large and not just in their small world of teacher and parent; abolish all tenure; and challenge or threaten legislatures to provide dollars for quality education.

This would destroy the system significantly enough to start us toward an acceptable model for productivity. But now, let us return to the real world.

The fundamental premise of the author is that the present basic decision-making structure is inherently limiting in reference to the cost-effectiveness of the system, and must be changed before applying a management model. While I accept this premise, the frustration of how to implement it leaves me very apprehensive about the future. Perhaps alternative schools can give us some answers.

He goes on to cite some examples about state aid in Indiana. I want to point out that in the state of New Jersey, state aid is based purely on average daily enrollment and has no relationship to the number of teachers. As everyone here knows, we rank very low among the states in state aid to education. We are faced with a strong local autonomy which places full authority for education in the hands of local boards of education. That means that the state government has little effect or practically none in directing change in the educational environment.

The Supreme Court, however, recently directed our department to provide guidelines for thorough and efficient education for all children in the state, and for the past six months we have been groping for a definition for "thorough and efficient." This, coupled with abatement legislation and revenue-sharing, may change the position of the department and its potential for providing that direction for change.

With regard to the function of federal aid, a good part of our problem could be solved if school districts were required to survey the community in advance of a proposal, and carry on a public relations campaign for the duration of the project. As educators we fail miserably in the area of promotion and public relations. A dash of Madison Avenue marketing technique would go a long way towards improving our image and getting public support for change.

When I began reading the author's comments on instructional management and national curriculum movement, it brought to mind my work with Professors Rutherford, Watson and Holton on Project Physics. Here, in my opinion, is a truly multi-media package for teaching physics. It had difficulty being accepted as a total instructional program because teacher attitudes needed to be changed. I might add that if anybody should be able to change, the scientific training and background of a physicist should make him the most amenable. However, he is not.

The National Science Foundation funded institutes at universities to train teachers. However, the participants were trained in a traditional college-oriented manner, and then asked to go back and change their teaching methods. To add further to the problem, the program was sold to a commercial publisher to be distributed. He is in business to make money, so he sold pieces to whoever requested them, which violated the integrity of the program. I might add that the authors were not too terribly disturbed. It did increase their royalty checks. However, in defense of this program, any pieces of change in the physics curriculum had to be an improvement over the deadly lecture method.

I believe that good educational programs can evolve from creative staffs if each was willing to change his role. This requires great attitudinal changes, which can be implemented with an IDI, where teachers in concert with board members, students, and administrators dedicate themselves to instructional problems and use a problem-solving technique to solve them. The textbooks then become secondary, and students have a new pattern to choose from among new modes of instruction.

But what about those 20-odd states where they employ textbook adoption? They have dictated curriculum to the publishing industry and still have a very important impact on what publishers will publish and what we use in classrooms aroung the country. Higher education has never had that problem. Why has change not occurred?

You do allude to evaluation and accountability. I feel they are pressing, especially to the elementary and high school teacher today.

In New Jersey, we recently instituted a statewide testing program and now we are starting with a norm-referenced test program. What can this do to instructional technology? We say we are moving towards a criterion-referenced testing program and, in my opinion, this would improve things considerably, especially for those districts using CAM as a delivery system. This hopefully will increase productivity. But, getting back to a question asked earlier, I do not know if there is any data to prove it.

Under the topic of certification and accreditation, the Addision Trail High School example could very well have been staged in a New Jersey school. The answer, however, is not "do not fund projects in such states," instead, there should be an attempt at the national level to correct such limited thinking by exerting pressure for special certification for paraprofessionals to include supervision of pupils.

Every summer thousands of young people are sent to camp and are instructed by college students (in swimming and other areas) without any certification or qualification to do so. It is ironic that parents pay far in excess of their school tax base to send their children to camp!

With regard to accreditation, we in New Jersey have abolished the Carnegie unit and have established that credits towards graduation shall be assigned on the same basis to all high school courses with a minimum of 92 credits for four-year institutions and 69 credits for the three-year school: a step towards implementation of innovation, I hope.

In conclusion, let the burden of responsibility be placed on us here at this conference to prove that technology can increase productivity, and can do so by reducing costs with a less labor-intensive system. Then, put pressure where it belongs to get greater amounts of money allocated to education, to be utilized in producing technology-based facilities for all new structures being built nationally. Concurrently, there should be a mandate issued to all teacher-training institutions stating that future teaching positions will be awarded on a performance/competency base and that all teachers will be expected to function in a technological environment.

This, of course, would require massive teacher-training institutes designed to produce teachers who could write good objectives, good test items and prescriptions. Then, if we abolish tenure and set up systems of management by objectives and PPBS, we can begin to attack the very essence of the productivity question.

MEASUREMENT FACTORS

THE EVALUATION OF EDUCATIONAL TECHNOLOGY

by

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INTRODUCTION

During the past years, considerable attention has been given to the need for conducting evaluations of educational technologies during the course of their introduction. When a new educational technology is being introduced into a school or a district, it must be carefully evaluated not only to assure that the technology is producing the desired results, but also to determine whether the technology is appropriate in relation to the unique characteristics and needs of the system, and to assure that the technology is being used properly during its introduction.

There is a need for evaluation, however, even prior to these stages during which technology is introduced into educational systems. Procedures of evaluation are required not only during the introduction of the educational technology into a system but also during the process of technology development itself. All too frequently the tendency is to focus merely on evaluation "during demonstration." This presumes that all technology has undergone appropriate evaluation during the development period -- to insure that necessary revisions have been made. This further presumes that all technology has had a final field test for validation purposes -- to indicate to potential users the conditions under which the materials have demonstrated success relative to a prespecified set of criteria. Unfortunately, evaluation of technology during development is more the exception than the rule.

Komoski (1971) documents these inadequacies. He notes that less than one percent of educational films are "systematically shaped through the learner try-out and revision process" -- that is, by utilizing formative evaluation data for product modification. Similarly, in the area of broadcast video taped instruction, "only a little over one percent of the television materials used in schools has been learner verified" (Komoski, 1971, p. 22). Even in programmed instruction, the area in which techniques for learner verification through formative evaluation and revision were developed, the situation is discouraging. "EPIE's examination of 633 of the programmed items now in use in major curriculum areas in schools revealed that research evidence was available for only seven percent of these materials while some field testing was claimed for another eight percent" (Komoski, 1971, p. 399).Generally, field tests of educational technology for validation purposes are performed on less than ten percent of all products.

EVALUATION OF EDUCATIONAL TECHNOLOGY DURING DEVELOPMENT

FORMATIVE AND SUMMATIVE EVALUATION

In other publications (Alkin, 1969), I have stated that the purpose of evaluation is to provide information for decision makers, and have maintained that "evaluation must take into consideration the ultimate decisions to be served." One classification of ultimate decisions to be served was suggested by Scriven (1967) who made the distinction between formative and summative evaluation. Generally, formative evaluation is used to describe the evaluation of educational programs that are still in some stage of development. Schutz (1970, p. 178) has said, "The product of formative evaluation activities is expected to be an improved instructional program."

In the evaluation of technology during development, formative evaluation is intended to provide data for revision of the educational technology. Summative evaluation, on the other hand, is intended to provide data for the validation of the technology. If summative evaluation refers to the final major evaluation effort of technology prior to its public release, and we assume that the intent is to validate the materials, then can we say that following this validation not an idea, not a paragraph, not a phrase, not a word will be changed, and that the published technology will be identical in every respect to the "validated" technology. The question then arises as to whether it is possible to conduct an evaluation which is not formative -- which does not lead to "revision." The strict definition of formative and summative, therefore, seems to preclude the possibility of a summative evaluation taking place.

In this regard, I would like to turn to the Stake (1967) distinction between formative and summative. He notes that "it is probably more useful to distinguish between evaluation **oriented to** [emphasis mine] developer-author-publisher criteria and standards and evaluation **oriented to** [emphasis mine] consumer- administrator-teacher criteria and standards" (Stake, 1967, p. 538). Thus, with respect to the evaluation of educational technology during development, we may make the distinction between formative evaluation **oriented to** the developer and summative evaluation **oriented to** the user.

FORMATIVE EVALUATION[1]

From the definition of formative evaluation provided above, it is obvious that a large part of the activity of developing an educational technology, or of educational product development in general, deals with formative evaluation. Indeed, the role of the evaluator in most instances neither is unique nor separate from his role in conducting the activities of product development. Formative evaluation is an inherent part of the product developer's role. Because product development and formative evaluation go hand in hand, they are frequently performed by the same people. In many cases, the supplier of this information -- the evaluator -- is also the developer. As a result, the evaluator selects and supervises the product's field testing plan, **and** translates the information he gets from the tests into product changes. Thus, it is important to note that when I refer to "the formative evaluator" in product development, or to formative evaluation data, I am referring to an **evaluative function** or role that could be performed by the developer himself.

In order to understand the formative evaluation functions during the development of educational technology, it is appropriate first to consider the product development sequence. Writers in the field of product development have identified two distinct development stages (Markle, 1967; Schutz, 1970). The first stage, that of prototype development, is a phase of activity that leads to a prototype technology ready for testing. After the prototype has been successfully tested, then during the second phase of development, the operational phase, any components and/or procedures that are needed to ensure that the technology is useful in a real-world setting are built into the already tested prototype. These development stages have an associated set of formative evaluation activities.

Evaluation conducted during the **prototype stage** is intended to verify whether the technology is capable of producing the desired outcomes. The evaluation data collected to assist in this judgment must anticipate the full range of decisions that might arise during the prototype development phase. Data gathered at the **operational stage** of development should be concerned not only with the level of learning achieved by the students, but also with the degree to which the whole technology functions as anticipated and whether or not it is approved by administrators and teachers who will be using it.

Each of these stages -- prototype and operational -- will be briefly explored in light of the data desirable for collection.

Prototype Development: (Instructional Sequence)

During the prototype development stage, the intention is to produce a prototype or prototypes that can be tested to determine their power in assisting the learner to meet the intended goals. In this development cycle, the designer attempts to generate an effective sequence. The choices of the instructional principles that will be used, the instructional approaches that will be selected, and the adequacy of the content in terms of comprehensiveness, importance, and accuracy must be carefully considered. It is assumed here that some sort of review of goals and try-out of measures has preceded the instructional design phase, but formative evaluators are responsible for verifying this assumption and to make sure that such try-out did take place.

What sort of data should be collected to assist in the potential revision of the instructional prototype? Two major classes of formative evaluation information are necessary: 1) Information about **product success** or the effects of the technology, and 2) Information of a **diagnostic** nature that should assist in the remedy of any deficiencies that may be discovered.

Product Success. Under category one, there are three major questions or areas of concern. The primary question relates to product success in meeting its goals. The data source needed to answer this question is how the students perform on the criterion set of tasks. Pretest data will be needed so that the amount of student improvement can be determined. In terms of product success, a second area of concern might be how the learner reacted to the objectives, the instructional sequence itself, and the approach that the instruction takes. These kinds of concerns are particularly important where learner affect toward the total package is concerned. A third area of concern, even in the prototype development phase, is the question of finding out if the technology is producing any undesirable or unanticipated effects. Free-discussion interviews might be conducted with subjects to help to uncover any misinformation that the materials are unwittingly generating.

Diagnostic Information. The second category of data needed in the prototype development stage is intended to provide diagnostic information that the developer can use to remedy any deficiencies and to make necessary alterations to the technology. Without such a data source, each modification will represent merely another unsubstantiated hypothesis, and probability of success will not increase with each formative trial. I will not discuss specific data sources used in the revision of prototype try-outs, but will, instead, present for consideration the following data issues: 1) Expert judgment, 2) Student-response data, 3) Student-critique data, and 4) Procedural considerations in data collection.

When **expert judgment** relating to educational technology is sought, it should be secured at the same time that the specifications of the product are being developed. Experts can respond to the selection of goals and content as well as to the adequacy of measures. However, one might also wish to have prototypes examined by content specialists, who might detect subtle errors in subject matter or sequence.

A second data issue deals with the use of **student-response data.** What is the pattern of errors that the learner makes on practice exercises involving parts of the technology? What other sorts of records of student behavior can cue the developer to the particular parts of the package that are not assisting learning? Data may be assembled from the actual responses the student makes during the process of instruction.

A third issue involves the use of **student-critique data.** Does the learner find particular examples provided to be helpful? Is the organization of the materials suitable? Is the level of language appropriate? Do any sections provide particular difficulty or confusion? Does the approach make sense to the learner? Data to answer these questions are all of a diagnostic nature.

There are a number of **procedural considerations in the collection** of evaluation data intended to assist in providing remedies to deficiencies in educational technologies. It should be clear that the prototype development try-out represents a case where the formative evaluator wants very detailed, specific information. The formative evaluator must plan to gather all data possibly useful for revision at this point, particularly since his confidence about the potential success of the program is low. Even if the development plan grew out of a set of carefully executed hypotheses, there is not sufficient reason to believe that it will be successful in all respects. Therefore, the formative evaluator should consider two points in the planning of the prototype development evaluation: first, that it is unwise to expose large numbers of students to untested instruction; and secondly, that students selected for the field trial should be expected to provide a rich variety of data -- e.g., both post-instructional and performance data.

Using small samples of students has the disadvantage of causing a loss of reliability on the data collected. An advantage of the strategy of using smaller samples means a shortening of turn-around time for necessary analysis and revision. Since prototype development is often of an exploratory nature and it is unwise to interrupt the development process with lengthy intermissions, the trade-off seems worthwhile. Loss of data reliability is more than offset by the advantage of using small samples, analyzing them intensively, and accruing the benefit of quick turn-around time for revision.

Operational Development: (Practicality)

Following the successful completion of the prototype development try-out (a formative evaluation stage which is likely to require more than one cycle), the development operation should then begin to be concerned with the usability of the technology in the range of anticipated settings. The formative evaluator conducting a field trial must direct his attention also to issues of practicality. If we resort again to the classes of data identified in the prototype development try-out, we find that 1) the effects of the materials should be assessed, and 2) diagnostic information should be obtained to assist in revision. Again, these same two questions are of concern to the developer at this point in the project.

Product Success. The first issue in the evaluation is always the extent to which the materials are succeeding with the learners. The same questions identified in the prototype try-out stage regarding the effects of materials on learner achievement must be reconsidered in the operational development stage of the formative evaluation of educational technology development. These are: 1) Student performance on post-instructional tasks, 2) Student attitudes and satisfaction with the materials, and 3) Unanticipated effects engendered by the materials. Such data are collected so that we can determine whether the translation of materials into operational status has in some way reduced the effectiveness of the learning sequence.

There are several questions requiring data that must be addressed at this stage. If a proper prototype development try-out has been conducted, many questions have already been resolved and materials have been modified based upon evaluation data. The questions that remain revolve around the extent to which the user is satisfied with the materials, whether they are feasible administratively, the students' responses to the integration of various components of the total technology, and the format chosen for instruction. Student satisfaction can be easily tapped on a questionnaire administered after the materials have been used. Administrator ability to implement and use materials can be assessed in several ways. Observers may record teacher behavior with critical material components. Teachers themselves may prepare reports on their daily successes and failures in using the materials.

Diagnostic Information. As has already been noted, in an operational field test the second major class of data is concerned with providing diagnostic information necessary for revision of the technology. Since the emphasis in a field test is different from that in the prototype development test, the potential kinds of revision activity also differ. In the prototype development field test, concern was with learning principles, adequacy of examples, and viability of approach. Thus, revisions of this type will probably have already been made and in the operational field test we will be more concerned with clarifying and simplifying directions to students and teachers, so that the materials can work within the limitations that are imposed by the various specific settings.

The field trial has another important function: it serves to identify (or to refine) the teacher/user training requirements to which the technology should attend. If teachers are systematically misusing given components and the developers wish to stay with their original design because of extremely positive prototype data, then the developers must add a teacher training sequence to assure that intended procedures will be followed.

Because a number of users is required, the number of students used in an operational field test is larger than in the prototype development test However, note that much of the difficult data to collect (observation, interview, and daily records), are expected of the teacher or program administrator rather than the student. Student data, where large numbers are employed, should consist of information that can be quantified fairly easily. Any more intensive scrutiny should probably be handled on a sampling basis, stratifying by teacher.

SUMMATIVE EVALUATION

Now, let us consider the role of summative evaluation as it relates to the development of educational technology. Who is the decision maker and what are his information needs? Typically, the summative evaluation report representing the final field testing of a technology is considered an attempt at validating the technology. Frequently, this summative evaluation activity is comparative -- the technology is compared to another marketed product thought to be comparable. Moreover, the appropriate procedures for having control groups that are similar and the typical protocols of research design are well known to the reader.

The three major areas of consideration in the summative evaluation of educational technologies while they are under development are: 1) the selection of criterion measures to be employed, 2) the collection of data, and 3) the statistical analysis.

With respect to the criterion measures to be employed, the major issue revolves around the question of whether to use criterion-referenced measures or norm-referenced measures.

The collection of data has its standard prescriptions, but one particular advance in strategy, the procedure of matrix sampling, is worth noting. Husek and Sirotnik (1968) have described a procedure to reduce the amount of student testing time requisite in assessment. Samples of test items are administered to samples of learners, and the sum across all items is used as an index of program success. Shoemaker (1972) has prepared a refined and expanded paper on the topic, describing multiple-matrix sampling, where samples of item-person matrices are repeated across time. Shoemaker demonstrates that such procedures are superior to the usual non-sampled test administrations in terms of the obtained standard error of estimate, and no worse than regular procedures in terms of the bias of the data. Such procedures are particularly appropriate when student time is at a premium and a set of coordinate objectives may be assessed by the evaluator.

The manner in which data will be analyzed is determined primarily by the experimental design used in the evaluation. Evaluators generally feel the necessity of using experimental design in the validation of programs under development. Attempts at such validation generally run head-on into the full set of problems related to the maintenance of controlled conditions in field settings. Some of these problems are discussed later in this paper. Difficulties of using experimental design procedures in the summative evaluation of instructional program development have been discussed for some time. For example, Hemphill (1969), in a particularly insightful article, has questioned the appropriateness of typical summative evaluation procedures in terms of their relevance to the decision-making framework of product development. I would concur; I return to the earlier question -- Who are the appropriate decision-makers? Who are the recipients of summative evaluation information?

Typical summative evaluation reports of products are oriented to decision- makers other than ultimate users, such as the director of the laboratory, center or development agency. Another decision-maker (or set of decision makers) are individuals at the Office of Education or at the funding agencies who sponsored the work. Now, what is the kind of information that these decision-makers require and demand? Since the summative evaluation report serves these two (and possibly other) decision-makers or decision audiences simultaneously, it must therefore address those issues which are of interest to both sources. Thus, one purpose of the evaluation is to demonstrate to the funding source that the developer of the technology has been "successful" (whatever that might mean). A second purpose of the evaluation is to demonstrate that the materials developed are in some way better for producing some intended set of objectives than competing materials, or that there are no competing materials available for the stipulated set of objectives. A third purpose of the evaluation is primarily to demonstrate the overall quality of a technology **rather than to specifically delineate the conditions under which it is most useful.** All of these purposes are intended to convince someone that a good job has been done.

The kinds of information and procedures to be employed in the conduct of a summative evaluation of educational technology development are dictated by the kind of report that must be produced. Further description of the sections of a report oriented to users is provided in Alkin and Fink (1973) and Fink and Alkin (1973).

The potential user of a new educational technology needs a report that enables him to determine whether the technology "fits" into his particular instructional context. As a minimum, such reports should provide the user with:

1) The name of the technology, its developer, distributor, general goal, and physical attributes and costs;

2) An operational statement of the technology's goals and objectives, and a description of the instruments which were used to measure student achievement;

3) A description of the background of the learners who can profit from instruction;

4) An explanation of the procedures actually employed to develop and test the technology to make it "work" -- the extent to which the technology utilized formative evaluation data during development to improve and revise materials;

5) A review of the empirical evidence that demonstrates the extent to which the technology effectively promotes learning and the differences in outcome attainment among different learner groups and within different school, community, and organizational contexts;

6) A summary of the evidence that the product is efficient in that it is exportable and/or can facilitate learning in cost-effective terms.

The summative evaluation of a technology would ordinarily occur following the completion of all of the formative stages of evaluation. Participants in the summative evaluation would reflect the wide range of audiences that would be considered the intended users of the materials. The technology should be used in the field setting by the teacher or other user and the developer should maintain a "hands-off" attitude. At this stage the evaluator would also be concerned with the collection of time and cost data as required for the user-oriented product report. Finally, it should be the intention of the developer of the technology that it will not undergo major modification (i.e., that it is in its final publication form) and thus the summative evaluation report will present validation data on the technology as it will be produced and marketed.

The exigencies of life do not always make these protocols possible, and we should be realistic enough to appreciate that fact. We must ask whether we have to accept the either/or position -- either the experiment goes as designed or we cannot call it a summative evaluation; either the program is not modified after evaluation or we cannot call it a summative evaluation; either the control groups were maintained or we cannot call it a summative evaluation.

I THINK NOT in all of the above. Surely there are desired procedures; surely the evaluator will attempt to maintain the controls to the greatest extent possible; surely the evaluator will hope that the materials will not be modified. But the prime constraint is the field context and the prime concern is the ultimate field user and the quality of the technology he will obtain.

Thus it may be very possible that the summative evaluation -- the user-oriented product report -- will provide data on a technology that has been modified in some ways, and the summative report must not only indicate the data findings but also supply information on the nature of the modifications that have taken place subsequent to the final evaluation. The potential users of educational technology under development are best served through the presentation of a user-oriented product report summarizing the best validation data available at the time of publication.

EVALUATION OF EDUCATIONAL TECHNOLOGY IN FIELD APPLICATIONS

I would now like to consider the evaluation of educational technology in its finished form as it becomes part of an on-going instructional program in the schools. There are several evaluation stages that may be considered in the evaluation of technology in field applications. Since the nature of the technology to be evaluated heavily influences the kinds of issues which must be addressed in these evaluation stages, I will consider here two contrasting kinds of product: a product which is a **total instructional system**, and one which is designed as **adjunct** to the instruction.

The term **total instructional system** (or "total technology") is meant to indicate that the unit is essentially independent of a teacher; either the teacher is not needed at all or else the teacher's role is so clearly specified and prescribed that the major burden of instruction lies with the technology. An **adjunct instructional product** (or "adjunct technology"), on the contrary, is designed to be added to an on-going instructional program at the teacher's discretion and under his or her direction. As such, it is more subject to teacher influences and is more teacher-dependent. The manner of its use and the context in which it is used will be more varied. In actuality, while I have dichotomized educational technologies, a more appropriate form of consideration might be a continuum beginning and ending with the two listed dimensions.

Let me consider now the evaluation of already developed educational technology products as they are introduced into instructional programs. I will assume that as a result of the formative and summative evaluation of the technology during its development stage, a body of data is available which describes in detail the instructional objectives of the technology, along with the implementation conditions and parameters that are likely to affect the achievement of these objectives. This kind of user-oriented report (from summative evaluation of development), which we will assume accompanies each technology, should be in a format which makes the information readily accessible to those who introduce the technology into the schools.

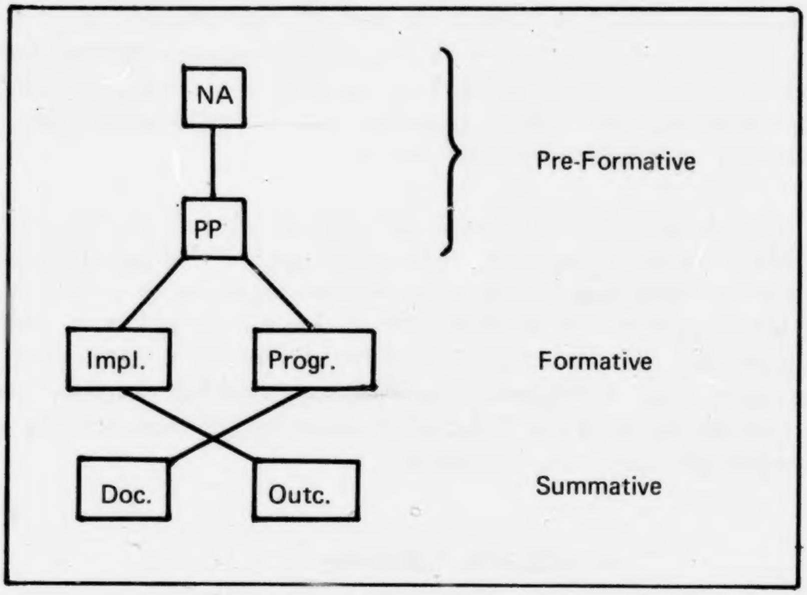
EVALUATION STAGES

The developed technology must move out into the schools and, at each stage of its movement from developer to district office to classroom to child, there are decisions to be made. At the Center for the Study of Evaluation, my colleagues and I have developed a model of evaluation which recognizes various evaluation stages related to the variety of decisions that must be made. This model is set out in Figure 1.

I have already discussed the distinction between formative and summative evaluation. When I discuss the evaluation of technology within the context of instructional programs, I feel that it is necessary within formative and summative evaluation to make further distinctions between two parallel sets of evaluation activities in each evaluation stage. Implementation evaluation and progress evaluation are the parts of formative evaluation, documentation evaluation and outcome evaluation constitute summative evaluation.

In the evaluation of educational technology in programs, I view a necessary **prior** stage which I refer to as **pre-formative evaluation.** This consists of two sequential sets of activities designated as Needs Assessment Evaluation (NA) and Program Planning Evaluation (PP). Each stage will now be discussed more fully, bearing in mind the distinctions in application necessitated by the evaluation of total instructional systems and by the evaluation of adjunct products.

FIGURE 1



PRE-FORMATIVE EVALUATION

Pre-formative evaluation consists of the set of evaluative activities that occurs prior to the implementation of an educational technology into a school setting. There are instances where pre-formative evaluation, consisting of needs assessment (goal setting and discrepancy determination) and program planning (the evaluation of program alternatives) has not taken place. In the absence of systematic pre-formative evaluation, it is often necessary to perform these functions retrospectively as a part (or perhaps more appropriately -- as a prior condition) to the formative evaluation.

Needs Assessment

Stating the objectives to be met and determining how well an existing program is meeting these objectives are the main activities of the needs assessment stage. A need is a disparity between what is desired and what is actually achieved. A needs assessment is the first step in pre-formative evaluation even though the evaluator must sometimes accomplish this step by retrospection. By identifying the need to which the new instructional program is addressed, the evaluation is placed firmly in context. The evaluator at this pre-formative stage must address four major evaluation steps in the needs assessment (Klein, et al., 1971). The first of these steps is determining the range of educational goals or objectives that will be examined. These outcomes may run the gamut from broadly-stated educational goals or philosophies to highly prescriptive instructional or behavioral objectives, depending upon such contextual factors as the size of the educational setting -- state, district, school, classroom, etc. The next step involves finding out the relative importance of these goals/objectives. This information is usually gathered by having the various constituent groups rate the goals/objectives in terms of their perceived importance. The third step is to assess the extent of the needs; that is, to find out the discrepancy between present and desired student performance on the goals/objectives. The information gathered in steps two and three -- importance of an objective and student performance on the objective -- is combined in the fourth step of the needs assessment to determine the relative importance of the needs.

By conducting this pre-formative stage of needs assessment, the evaluator has identified a full range of potential educational needs and their relative priorities. This information is used to justify focusing attention on particular needs, to provide baseline data that can be used to assess subsequent changes in student performance, and to facilitate program planning decisions concerning the selection of educational technologies by focusing attention on the potentially important needs and decisions.

It should be mentioned parenthetically that although in a strict systems approach needs are identified and then technologies are developed to meet these needs, life is sometimes richer and less linear than logic. The availability of a particular validated technology may **occasionally** inspire attention to a need rather than the converse. For example, a school district may have felt that the development of a qualitatively different program for gifted students was beyond its resources and therefore decided to ignore or rank at low priority the need for such a program. If, however, the district then became aware of the existence of an already-developed instructional technology which could easily be purchased, then a decision might well be made to attend to this neglected area which had been held in abeyance.

Program Planning

The selection and/or modification of an instructional technology appropriate to the needs which have been identified constitute the major activities of program planning evaluation. One source of data input in this evaluation activity is the data the product developers provide regarding their instructional technology. The better the user-oriented product report for the technology under consideration, the more informed and effective these selection decisions can be. Other evaluation data about a technology might come from an examination of the instructional product's objectives relative to desired objectives. Another concern is with the potential success of the materials on the specific instructional setting of the district. Evaluation procedures to be employed to obtain this information may range from trying out the material in simulated settings (Alkin & Bruno, 1970), to expert judgment derived in a systematic fashion such as from use of the Delphi technique (Helmer, 1966; Adelson, et al., 1967).

During program planning, which concludes the pre-formative stage of an evaluation, the concern is with making decisions relative to the selection and/or modification of technology. The major decision revolves around the question of how the identified needs might best be addressed, and which technologies might be adopted, given the resources available to do the job. In this stage, a planning document will normally be developed in order to specify how the desired objectives/outcomes will be achieved. After the evaluator has helped the potential user to identify the technology most appropriate to his need, his task is then to provide advice regarding the evaluation requirements for the alternate plan, and to build **into the planning document** the procedures that will make possible the subsequent formative evaluation of the program and the new/or modified technology it will adopt.

FORMATIVE EVALUATION

I view formative evaluation as logically consisting of two parts -- implementation evaluation and progress evaluation. The former considers whether the instructional technology that was specified as being appropriate is what is implemented -- "Is what you got what you said?" The latter deals with the changes produced or the progress in pupil performance -- "Is what you produced what you wanted?"

Implementation Evaluation

In implementation evaluation the extent to which the technology was implemented as planned is the prime focus. All the described components of a technology must be monitored to determine if they are being implemented in a satisfactory manner. Personnel (students, teachers, and staff), physical arrangements, including scheduling and communications, and instructional context must all be considered. Unless such issues are examined early in a project, and corrective action taken where necessary, a project may fail because it was never properly implemented.

Since implementation evaluation is concerned with whether the procedures specified in the program plan (the focus of pre-formative evaluation) are being carried out in the intended manner, the evaluator must investigate how the plan has been adopted or implemented in the field situation. Typical implementation evaluation questions for which information is needed are "Did the books (as part of the selected technology) arrive on time?", and "Are the students enrolled in the program (and using the technology) the ones for whom it was intended?" This kind of information deals with the extent to which the program is functioning properly, and may be used to make decisions regarding possible changes and modifications in how the program is being run.

In the case of a "total instructional system" we might expect the implementation evaluation to be a lengthy but straightforward process. Each step of the implementation must be thoroughly checked: Are materials being correctly utilized? And are they being used by the person(s) for whom they were intended? Are any steps in the prescribed sequence being omitted or performed out of order? Are materials available as needed and readily accessible? The desirable conditions of implementation should have been clearly described as a result of product development and the evaluator in the field must note, in his implementation evaluation, any lack of congruence between conditions as envisaged by developers and those encountered in actual practice. Such information may be crucial should the instructional technology fail to produce the anticipated outcomes. There have been many disappointments due to optimal conditions of use in the development stages being followed by suboptimal conditions in the field.

I would anticipate that there would be fewer implementation evaluation activities associated with the evaluation of an "adjunct product" than with the evaluation of a total instructional system. Ordinarily, the less extensive or complete the technology, the fewer the number of prescribed instructional characteristics to be evaluated in terms of the extent of their implementation.

Progress Evaluation

In progress evaluation information is provided about the progress made towards meeting the instructional objectives. The data in such an evaluation are derived from student achievement measures and they are evaluated in terms of whether the achievement of objectives is on schedule and at the anticipated level. The purpose of this activity is to provide timely information for improvement of the instructional technology in terms of appropriate modifications for the particular school context. Technologies are produced and validated but they cannot anticipate the wide variety of particular situational constraints that might be encountered. If progress is not satisfactory, then modifications must be tried and the implementation must be checked with a view to getting things back "on course."

At this point the similarities and differences between implementation evaluation and progress evaluation -- the two parts of formative evaluation -- should be apparent. Whereas implementation evaluation deals with the extent to which **procedures and processes** are implemented as planned, progress evaluation is conducted so as to determine the extent to which these processes are producing the **desired** gains in school performance.

In the case of a total instructional system, assessment of student progress at regular intervals during the use of the materials has almost certainly been included as a part of the instructional materials. In the use of this assessment data, the evaluator must be aware of the time factors involved. Is the **rate** of student progress such that the objectives will be attained in the anticipated time? If not, this information must be provided to the appropriate decision-makers.

In the case of an adjunct technology, it is less certain that student assessment has been already built into the product. Furthermore, because the product is viewed as an adjunct, or a component of a larger instructional sequence, there are superordinate objectives that must be considered. In designing measures of student progress, then, the evaluator must consider not only whether product objectives are being met but also if the achievement of these objectives is facilitating progress towards the superordinate course objectives.

During progress evaluation the evaluator should also be alert to the emergence of unanticipated trends. He may, for example, note positive cognitive gains occurring as anticipated but also see an increasing discontent among students. If such an unanticipated trend in the affective domain were ignored, unsavory situations could ensue.

One further consideration should by noted here. To the extent that the technology is mediated, the decision-maker will have difficulty in responding to formative evaluation findings other than those related to implementation. That is, it may not be possible or feasible to consider changes in a technology the components of which were costly to produce and which are presumed to be systematically dependent upon each other. Thus, progress evaluation (formative evaluation for improving the technology) shrinks in importance in a highly mediated system and therefore depends to a greater extent upon appropriate and complete formative evaluation during the product development stages.

SUMMATIVE EVALUATION

Summative evaluation is concerned with providing data that can lead to generalizability decisions. Thus, one result of a summative evaluation may be a decision to introduce the instructional technology into other schools, to continue to use it, or to drop it. I view summative evaluation as consisting of two parallel phases, documentation evaluation and outcome evaluation.

Documentation Evaluation

The discussion of an evaluation stage concerned with documenting program activities has been set forth most fully as a part of the evaluations conducted in the Experimental School Program sponsored by the National Institute of Education (Budding, 1973). The documentation phase is concerned with providing a thorough chronicle and descriptive record of the instructional technology as it actually occurred. Any summative judgments about the technology, therefore, can be made in the context of understanding what did occur and what constituted the educational technology and its characteristics.

In documentation evaluation it may sometimes be as important to find out where materials **are not** being used as to describe where they **are** being used. For example, if a classroom is serving as a control group it is important to see that these students are not invited to watch the "nice new films" the experimental group is enjoying. In the evaluation of BSCS materials, for example, it was found that the equipment tended to spread out in a school and be used in control as well as experimental classrooms. The danger of such contamination of a control group is particularly great where classrooms rather than schools constitute the unit of sampling, but the possibility of contamination should be examined and noted in either case.

In the case of an adjunct technology, the documentation evaluation will be more complex though perhaps less voluminous than that for a total technology. In the absence of prior instructional specifications of the context in which adjunct materials will be employed, it can be anticipated that their use will occur in more varied settings. The evaluator will need to document and describe the frequency of use, the context of use, its location in the instructional sequence, the length of time allotted to the materials, and so on. Rather than checking the congruence of use with product specifications, the evaluator's job in the case of adjunct materials usually will be to provide adequate description and documentation of their varied uses.

Outcome Evaluation

The major concern in outcome evaluation is to provide information about the successes and failures of the technology. It should be noted that in this stage of the summative evaluation the concern is with providing data that can be used to judge the general worth of **all** of the components of a technology. These data must be interpreted in light of information derived from the documentation evaluation activities. Thus, to some extent not only the successes and failures but also the probable reasons for these outcomes can be reported. The generalizability of the results of the study should be carefully and explicitly assessed to avoid misapplications of the findings.

When should summative evaluation be conducted? It is not mandatory that the evaluation occurring at the end of the deployment of the total instructional system, for example, be summative. Summative evaluation is conducted to provide information to decision-makers so that they can judge whether to accept or reject a technology. Such decisions might be premature at the end of a first run of some total technology. Though the teacher's role may be minimal, smooth management of the technology might aid student learning and the teacher may require practice in his new role. Perhaps more important is the need to wait for the Hawthorne effect to wear off. Sufficient time should always be allowed for new technology to become both successfully established and boring.

In the case of adjunct technology, where use is very much at the teacher's discretion, time should be allowed for the manner of use to settle down to some fairly stable pattern. Therefore, it is not reasonable to request summative evaluation until implementation evaluation indicates that such settling down has occurred. As in formative progress evaluation, the summative outcome evaluation of adjunct materials must attend not only to the stated objectives but also to the contribution these objectives make to the achievement of superordinate course objectives or goals.

ISSUES IN EVALUATION OF EDUCATIONAL TECHNOLOGY

There are a number of possible issues that might be addressed relative to the evaluation of educational technology. Any listing that might be presented is of necessity limited and subjected to the individual bias of the particular author. Such is the case with the sampling of issues that follows.

NORM-REFERENCED OR CRITERIA-REFERENCED TESTS

Most people are, by now, well aware of the criticisms that have been leveled at standardized, norm-referenced achievement tests for use in program evaluation. The effects of an instructional process, the argument goes, must be assessed by examining student achievement **on the objectives of that instruction.** Standardized tests are frequently **insensitive** to instruction and mainly pick up variance between pupils which is due to ability. (Glaser, 1963; Popham & Husek, 1969; Klein, 1970).

In the case of adjunct technology it is highly unlikely that the effect of its use could be detected from the scores on standardized tests. The evaluation of adjunct products must be at a more detailed level. Measures should be developed objective-by-objective and referenced to desired performance criteria on the objectives.

In the case of total instructional systems, the issue is less clear. In a highly focused area, such as beginning algebra, it is quite likely that the items on a standardized, norm-referenced test **are** relevant to the instruction provided by the technology. However, because of the way items are selected for norm-referenced tests, students who have learned similar amounts of algebra will be differentiated on the basis of ability by the norm-referenced test. I would therefore recommend that the tests which are used for the evaluation of educational technologies be referenced to the specific objectives of the program. Items are selected for such tests on the basis of their content validity, not their statistical characteristics. Furthermore, results from such tests are not reported and analyzed in terms of total scores but in terms of scores on each of the objectives achieved. In this way information is provided concerning which program objectives are being successfully achieved.

In the instances where the use of criterion-referenced tests is either not possible or not feasible (e.g., political necessity for "standardized test," time not available for test construction, or criterion measures not available), then it is absolutely essential that the tests that are selected correspond as closely as possible to the specific objectives of the technology. Several handbooks that evaluate available tests have been published recently to assist users in making criterion reference-like test selections from existing norm-referenced tests (Hoepfner, et al., 1970; Hoepfner, et al., 1971). In essence, the procedure used in these test evaluation books has been to criterion-reference all published norm-referenced tests by placing each into the goal area in which it best fits and then rating each test's content validity for the category in which it has been placed.

Summative evaluation is frequently concerned with comparing two alternative instructional systems, such as a conventional beginning-algebra course and a programmed, media-based course. In such a situation, as Popham (1972) has pointed out, three groups of objectives should be considered: those objectives specific to each of the two courses and those common to both courses.

Although the procedure helps to clarify thinking about the two courses, additional data are required. Judgments are still needed to make decisions: judgments, for example, of the relative **desirability** of those specific objectives which are actually attained by students in each of the two courses.

MEASUREMENT IN THE AFFECTIVE AREA

It has not escaped the multi-million dollar attention of Wall Street that media can have a strong impact upon attitudes, beliefs, and behavior. This same fact must not escape our attention in the field of education. Schools are concerned with non-cognitive beliefs and behavior -- i.e., with the affective domain. Drug-abuse, sex-education programs, violence in schools, and anomie are all programs or problems in schools that require a concern for student attitudes. Multi-media educational technologies seem to offer great possibilities for effecting change in the affective area.

One of the major problems related to the development of technology designed to attain affective outcomes is the relative inability to demonstrate the attainment of these outcomes. There is a substantial lack of measures in all but the lower-order cognitive domains. As an initial step in enhancing the availability of whatever measures do currently exist, Research for Better Schools and the Center for the Study of Evaluation have jointly compiled a listing of available measures in the higher order cognitive, affective and interpersonal areas. The measures have been classified into sub-category domains and rated in terms of a number of technical and administrative criteria (Hoepfner, et al., 1972).

THE TIMING OF OBSERVATIONS

The timing of observations can have a considerable influence on the results obtained. If one wishes to measure retention and not just immediate learning, some testing must be carried out weeks or months after the application of the technology. Those concerned with the evaluation of instructional systems must pay heed to the most appropriate time for the collection of valid summative data. For example, as Lumsdaine has noted, "the prevailing pattern of results is a decrease in knowledge or skill for all forms of instruction, and, not infrequently, the finding that differences originally found between treatments have 'disappeared' or can no longer be demonstrated as significant statistically" (Lumsdaine, 1966, p. 649). While this phenomenon of diminishing effect may be typical in the area of **cognitive** outcomes an entirely different situation is likely in attitude change. An immediate posttest may show little effect, while a test administered some time later may show increased change. This kind of testing consideration would be important, for example, in the evaluation of drug education programs. Initial resistance to the cautionary message may be present but the warnings may gradually sink home later.

USER-ORIENTED PRODUCT EVALUATION REPORTS

In prior sections of this paper I have indicated the tendency of the evaluators of technologies to ignore the importance of preparing user-oriented product evaluation reports. In their reporting, evaluators have primarily focused on decision audiences consisting of product developers, the directors of the development organization, and funding agencies. Thus, technical reports are generally inappropriate for users -- such as the teacher in Philadelphia or the curriculum coordinator in Los Angeles. These kinds of users, confronted with an ever-growing array of educational technology, should not have to sift through the avalanche of development data contained in technical reports before they can decide what materials to buy. In recognition of this need, a few development organizations have attempted to provide users with conveniently assembled information about technology, while other agencies like the Educational Product Information Exchange (EPIE) offer product reports. Nevertheless, developers of educational technology continue to fall short of their obligation to the user.

Some of the responsibility for this lag also belongs to the commercial publishers whose job is, of course, to sell products. Publishers often tend to over-simplify a technology's usefulness and to over-emphasize its scientific development. Supplying information to users of educational products would represent additional expenditures to commercial publishers, and it is simply not good business for the publishers to reduce profit margins by collecting and reporting information that the consumer has not asked for. And that is the case: potential users of educational technology have not yet become sufficiently sophisticated to call for and expect comprehensive and readily understandable information before making their decisions, most of which are usually based on the reputation of the commercial publisher and the academic qualifications of the authors of a given product.

Inattention to the preparation of educational product user reports is partially due to the product developers'/evaluators' concern with the development process, partially a function of the commercial publisher's priorities, and partially the effect of a lack of consumer demand. In addition, given the usual empirical/statistical/methodological background of most evaluators, the technical reports that they write may be considered as a means of demonstrating to their colleagues that even though they have left the university world of pure research, their scholarly tradition is still untarnished.

The problem remains of how best to stimulate summative evaluation during product development and bring about the preparation of user-oriented product reports. (Perhaps the issue is even broader in that what is required is the encouragement of evaluation activity throughout the whole development cycle.) In another paper, I have discussed the potential role of the Federal government in stimulating evaluation activities during the development of educational technologies (Alkin, 1970). In that paper I advocated, as one alternative, the use of Federal incentives for school districts to use products that have been properly validated. As another alternative I suggested the possibility of providing Federal support for the external validation of educational technologies. The criticality of the problem of use of unvalidated materials requires the consideration of these as well as other possible alternatives.

THE VALUE OF THE EVALUATION OF EDUCATIONAL TECHNOLOGY

School districts today generally operate under severe budget constraints. Not only are funds limited, but within the funds available there is little flexibility in the way they can be allocated. In California, for example, 80 percent of the current expenditure budget is absorbed by programs mandated by the state. School boards are consequently very budget-conscious and need evidence of the cost-effectiveness of educational technologies before embarking on innovative programs.

Evidence of cost-effectiveness can only be derived from well developed and executed evaluation studies. "There is a need to perform massive and systematic evaluations of technological innovations in real-world situations which allow the evaluators to measure and consider the impacts of instructional treatments, societal and organizational contexts of these treatments, and multiple criteria. In short, what are required are large-scale field evaluations which reflect a total behavioral science viewpoint" (Alkin, 1969, p. 497).

Such large-scale efforts for the evaluation of educational technology hold considerable promise for at least two reasons. First, educational technologies have as a common characteristic greater specificity; thus, they have the great virtue of stimulus control. One knows, after study, what the treatment was. Exactly what has happened in other innovations is often difficult to ascertain: a teacher's aide was provided, but was she a representative sample of all teacher's aides? An in-service program was supposed to change teacher's classroom behavior, but was this change only manifested during the observation periods? In contrast, if one evaluates technology one generally knows what has been evaluated. Year after year, a carefully contrived and controlled technology will provide a constant source of energizing stimuli to each new batch of energy-laden youngsters. Secondly, technologies are, by their nature, more replicable and exportable than other instructional programs. For these reasons, thorough field evaluations of educational technologies are likely to yield a significant payoff in productivity in the schools.

FOOTNOTES

1. This section of the paper has been adapted from Baker, E.L., and Alkin, M.C., Formative evaluation of instructional development. AV Communication Review, (in press).

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DISCUSSANT'S REMARKS

Representing Teachers -

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ELEANOR LONESOME'S REMARKS

I am appalled that such a large percentage of products is marketed and sold without evidence of field testing. Perhaps what is needed is an Association for the Evaluation of Educational Technology (or of all products) which would publish standards and have some control over the quality of the product that could be published. As it is, the consumer gets only as much as he demands, it seems, and I blame the school district that authorizes the purchase of such a product. However, the integrity of the developer and his publisher should also be questioned. Somebody has to take the responsibility for having things field-tested.

Focusing for a moment on schools and school districts and how they make decisions about which products to buy, it is my contention that no purchase should be made from a set of counting rods to a total instructional system unless it is recommended by the division of research and evaluation or knowledgeable persons, in the various curriculum offices, who presumably are sophisticated enough to review a product and evaluate it in light of evidence that it is suitable for use by students in that particular district.

In his report, Dr. Alkin describes the minimum kinds of information a potential user needs in order to make an intelligent decision. It appears that with a report like this on every product, which he says is not forthcoming, committees could make good selections.

When shopping is done at the school level, I think principals and teachers should not be talking to publishers, because there are too many and it would be a waste of time. I think they should be seeking the advice of school district personnel who know the needs of the school and have already evaluated a selection of products from which the school staff may choose. This does not preclude the necessity for administrators and teachers to serve on committees to evaluate materials. I think they do need to do that also.

If the research and evaluation divisions or other central office personnel take on this responsibility, then maybe they can demand reports in order to make intelligent decisions. If the publisher is required to furnish comprehensive reports in order to sell, then pressure will be put on developers to do a better research job.

From my experience in how we order things in the school, especially in reference to textbooks and instructional aids, what happens is that we get lists of these things and we assume that someone has decided that they are good things for us to choose from and to use. But we are never given the opportunity to see the materials. Maybe there is a place where these things are, but teachers are not given the opportunity to go and look at the materials; so we have to make decisions about which things to buy, sight unseen. And we do not have very long to do it. The principal gives you the list one day, and he says that "in two weeks a requisition has to go in, so get into your grade groups or your subject matter groups and decide what you want to buy." We do it by trial and error. You order a set of books this year, and then if you do not like them, you put them on the shelf in the book closet, and nobody uses them. Next year, when the time comes, you do the same thing again. But this time you order a different set of books. So books pile up on the shelves, along with other instructional aids, kits of all kinds, and the principal does not usually seem to be too concerned.

I do not know if the principal has the freedom to use monies in different ways, but at some point he might be able to say "it looks as if we do not need any more textbooks this year, so let us use that money to buy something else." But he continues to spend that money for textbooks and some other money for instructional aids, regardless of whether you need them or not.

Regarding the evaluation of technology during development, I am interested in the point at which you get input from the experts and the teachers. I want to be sure that when it gets to the point where children are interacting with these materials, that you have already had your input from the so-called experts, so that what the children are addressing themselves to is close to the finished product and not bad material.

I think now that we have to have measurable objectives for all that goes on, it could reach the point where children would be spending as much time being tested as they were attending to the learning activities. Matrix sampling procedures, I think, should be used wherever possible if they can help cut down testing time.

The technique of gathering data through use of the questionnaire cannot be effective until teachers and administrators are convinced that the findings will actually be used to improve instruction. When will somebody, at some time, please give some feedback on the information collected. A contributor would at least like to know the extent to which his opinions were validated by like responses from others. When teacher evaluation is critical, he should not have to do it on his own time or on student time, because then he really does not do the job.

I think, in general, the importance of research and evaluation, if it is important, needs to be emphasized to teachers and principals. Principals want evidence of differences between groups, but do not want to release control groups for the necessary testing and retesting. Perhaps the use of matrix sampling will make the whole testing program less time consuming.

I believe something was said about being sure that control groups are not contaminated by things meant for experimental groups. I also think teachers should not know they are handling a control group. When they do, they tend to overcompensate, and I do not think that is what you want to measure. The teacher may be encouraged to neglect some other area while overcompensating in the control group.

Implementation evaluation, it says in the paper, is certainly a crucial stage in the development of an effective program. It would be irresponsible to neglect conscientious evaluation of the implementation plan until discouraging results of the progress evaluation developed. By that time, the program could be so out of hand that a whole term's work could be lost, and teachers might be so frustrated that they would be unwilling to use the product again. It is extremely important that principals monitor activities closely to see that teachers are getting adequate support, especially when they are using systems of instruction for the first time, and when they represent departures from the usual instructional style.

Teachers have concerns such as: Are the materials readily accessible? Do the machines operate efficiently with a minimum of breakdowns? Are replacement parts such as bulbs and batteries available? Are the promised aids always present?

Conscientious teachers want to implement programs properly. They are encouraged when evaluators are consistent, and they are encouraged when their suggestions are considered. They need positive reinforcement when the job is done well.

Also, where you have skillful teachers, you may have progress shown that is not due to the use of the product as prescribed. For example, when a system proposes to be total, but the teacher finds that she must plan separately for individual differences not provided for in the system -- and does -- then evaluation should report how and to what extent those deviations from the plan were made and why they produced positive effects.

When a performance contract is operative, I imagine summative evaluation takes on added importance. Many times teachers under performance contracts hesitate to make adjustments as they normally would, because they do not want the product getting the credit if it is not doing the job. It is not, in this case, that the teacher wants personal recognition, but that she does not want a decision to continue using a program to be based on progress made in spite of the program. Students are the victims when this kind of issue arises.

During my 12 years of classroom teaching, I was never aware of a real attempt to evaluate an adjunct product, except for an occasional questionnaire from which there was never any feedback. I am happy to know that that concept is around, and I think that if it were carried out, teachers would be more consistent and efficient in their use of these products.

As to the case in favor of the use of criterion-referenced tests: why teach one thing and then test for another? It simply does not make sense. Teachers have always despaired that the only progress reports made public are scores on standardized tests. This fact has given rise to the practice in some schools of teaching the test items outside the context of actual instructional objectives. Therefore, you do not get standardized results from the standardized test.

Also, Dr. Alkin mentions the possibilities that criterion measures are not available or that time is not available for test construction. This state of affairs might be forgiven where teacher-developed instructional sequences are concerned, but maybe, hopefully no school district will invest in educational technology when criterion-referenced tests are not part of the package. Since the tests can be developed from the behavioral objectives, I would think that they should be available even before the product is ready.

Effective evaluation before and during development of a product will insure a better product placed in an environment where optimum results are likely. Effective evaluation during the implementation will assure a more content and efficient user. A good product used in a suitable environment by an enthusiastic consumer is bound to produce significant results. So effective evaluation is definitely one of the keys to open doors for the expanded use of educational technologies, both adjunct and total, in our school districts.

FUTURE OF SOCIETY

SOME CONJECTURES REGARDING SOCIETAL FUTURES AND THEIR EDUCATIONAL IMPLICATIONS

by

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INTRODUCTION

It borders on temerity to attempt in a few pages to piece together a verbal mosaic of societal trends and the educational futures to which they may carry us by 1985. Yet such an effort needs to be made because societal factors provide many of the threads in the fabric of the topic we are considering, namely the future implications of such changes for schooling in the U.S.

In the pages that follow, our conjectures about societal futures will be based on an examination of the sweep of change, especially in the 30 years since 1943, and of the challenges they have created for humankind. In the light of these changes, attention thereafter will be focused on educational changes we may wish to contemplate during the crucial years between 1975 and 1985. Specific changes in structure and instructional methods also will be proposed. The final section of the paper examines some of the possible new emphases that may occur with respect to the content of instruction.

THE SWEEP OF SOCIAL CHANGE: 1900 to 1950

It is exceedingly difficult for many of us to contemplate the changes that have taken place in society during the past 70-odd years of our century -- especially those persons less than 40 years of age. Even more difficult is the task of comprehending the impact of the past 30 years. Let us briefly look at the 1900-1950 interval, then scan more closely the exponential changes that have transpired since 1943.

The U.S. of 1900, in retrospect, was a foreign land, a quaint country in which ways of life, values, daily tasks -- in fact, every dimension of society -- was so different from today as to belie the evidence of one's senses if he were to return from the 1970's to his grandparents' world. In all the U.S. of 1900, only 13,824 automobiles were registered, fashion dictated that women's skirts literally brush the streets, there was but one divorce for every 13 weddings, and Andrew Carnegie's personal income in 1900 was $23,000,000 -- out of which he paid not one dime of income tax.

The changes for most of the next 40-odd years, 1900-1940, were going to be gradual. There would be at least a little time to become adjusted to the immediate impact of technology on society and its potential catalytic impact on emerging social futures. Wages went up from an average of less than $500 per year that U.S. workers made in 1900, but in 1935, some beginning school teachers earned as little as $400 annually. Their average **lifetime** incomes were but little less than the **annual** 1973 salary of a secondary school principal in a large city.

Why the retrospect? Why the backward glance? Because our conjectures about societal **futures** are intimately related to an understanding of the wrenching changes that struck us after 1940 and that led to the great twin crises of saturation and of rapid metamorphoses that ended the familiar, relatively leisurely transitions of centuries past.

THE UNIQUE SOCIAL SIGNIFICANCE OF CHANGE SINCE 1943

The unique significance of the past three decades resides in the sudden impact of the now familiar phenomenon of "future shock," a term first minted by Alvin Toffler in a magazine article written about five years before his best selling book of the same name added the phrase to our idioms. We are, Toffler wrote in 1965, suffering from "...the dizzying dis-orientation brought on by the premature arrival of the future."[1]

Let me put it this way. The developments and changes -- predominately technogenic -- since 1943 have translated us into a strange world of different moral codes, novel behaviors, and unfamiliar devices which we can no longer repair or understand. As a result many of us feel out of touch with the secure realities of yesterday: we are sometimes almost like aliens in our own day and our society, and often feel alienated as well. One of the important prerequisites to our understanding of conjectures about societal futures, then, resides in an understanding of how technogenic change since 1943 has created a number of our new sociocultural disaster areas.

The year 1943 seems a good base date to choose, but not merely because it happens to be an even three decades past. It was in this year that a small group of scientists and technicians (in celebration of a top-secret event) broke out champagne and chianti in their laboratories under the old University of Chicago football stadium at Stagg Field. They were jubilant because, in the form of a mathematical model, they had sealed the fate of Hiroshima. They had perfected -- in theory -- the first atomic bomb. It was childhood's end for the human species; the beginning of a new era in which, as the French scientist, Rostand, phrased it, technology had made us gods before we had learned to be men.

Since 1943 events, often related to technology, have transpired so rapidly that we are hard-pressed to adjust to them. The developments that have impacted society are related to a mix of inventions, innovations and events. Consider the following:

radar

jet aircraft

atomic/nuclear power

pandemic TV

artificial life

cloning or "xeroxing" living things

holography

moon landings

ecothreats

energy crises

lasers

manned space station

supersonic speed

continuing inflation

and so on

Sputnik

growing aspirations

heart transplants

social unrest

dissent

planetary probes

Martian photographs

To put it in vivid terms, there probably have been as many technological changes and societal side-effects since 1900 as there have been in all the previous centuries of which history has provided remembrance. We have been propelled from yesterday to tomorrow with virtually no time to adjust to the leap.

BASIC CHALLENGES CONFRONT TOMORROW'S SOCIETY BECAUSE OF RECENT EXPONENTIAL CHANGE

Exponential changes of the past 30-odd years in particular have created intriguing and in some ways potentially frightening technofutures, biofutures and sociofutures. It is not my mission, nor do I have space in this paper, to explore them as I have elsewhere.[2] However, in dealing with the educational implications of societal futures, I find it necessary to probe the cluster of very real crises that presently face the schools. These crises, of course, permeate all of society -- but since the schools are a mirror of society, albeit sometimes distorted, they directly confront both **schooling** as well as **education** conceived more broadly than schooling in the U.S.

The crises-cluster is in itself a crisis, or as John Platt called it, a crises of crises. Among these critical challenges to society and to its educational enclave are:

1) Our lack of certainty as to what to believe and what to believe **in**...

2) Disagreement as to the good life...

3) How to cope with the problem of equity: the question of what is **fair** rather than merely **equal**...

4) The question of how power can be wielded without being abused...

5) The denial of authority that has grown out of the decreased credibility of social agencies: schools, courts, the federal government itself...

6) The diminished ability of social institutions to perform such wonted functions as governing, schooling, distributing, and selling...

7) The tacit rejection of democracy: the concept of the U.S. "democratic way" is a means of rising above one's station rather than a means of creating an equalitarian society...

8) The lack of a future-focused role image (FFRI) for children and youth in the U.S; i.e., the absence of a motivating concept of a realistic and satisfying role in the world in which today's school population will find itself...

9) The danger that belligerent survival tactics inherited from the past are now inconsistent with our future survival...[3]

10) Naive exploitation of technology...[4]

11) Failure to confront the problem of the maldistribution of wealth in a world in which 1 1/2 billion people have an average income of less than $100 per year as of 1973.[5]

12) The basic befouling of the human environment, concomitant, biospheric problems including marked resource depletion.[6]

Persons engaged in futures research generally recognize that many of the dozen components of the cluster of crises listed above were created over a 50-year interval and that given enough time their explosive potential can be lessened and perhaps totally defused. However, basic policy decisions as to how we can best proceed to disarm our crises probably need to be made by no later than 1985 -- a year beyond Orwell's gloomy world of tomorrow -- lest irreversible and irreparable damage be done to the "closed system" earth on which over 3 billion humans travel through space. This 12 year period gives us very little time and provides a tremendous task to education -- once the prerequisite social decisions are taken so that education has new goals for an unprecedented era. These social decisions, by the way, are decisions we are pressed to make in the U.S. before the remainder of humankind confronts them. Americans are in the lonely position of having advanced toward relative affluence so rapidly that they are the first nation required to determine what to do today about such problems as a surplus of trash and garbage, dying lakes, smog from automobile fumes and water tables threatened by the use of inorganic nitrogen fertilizers.

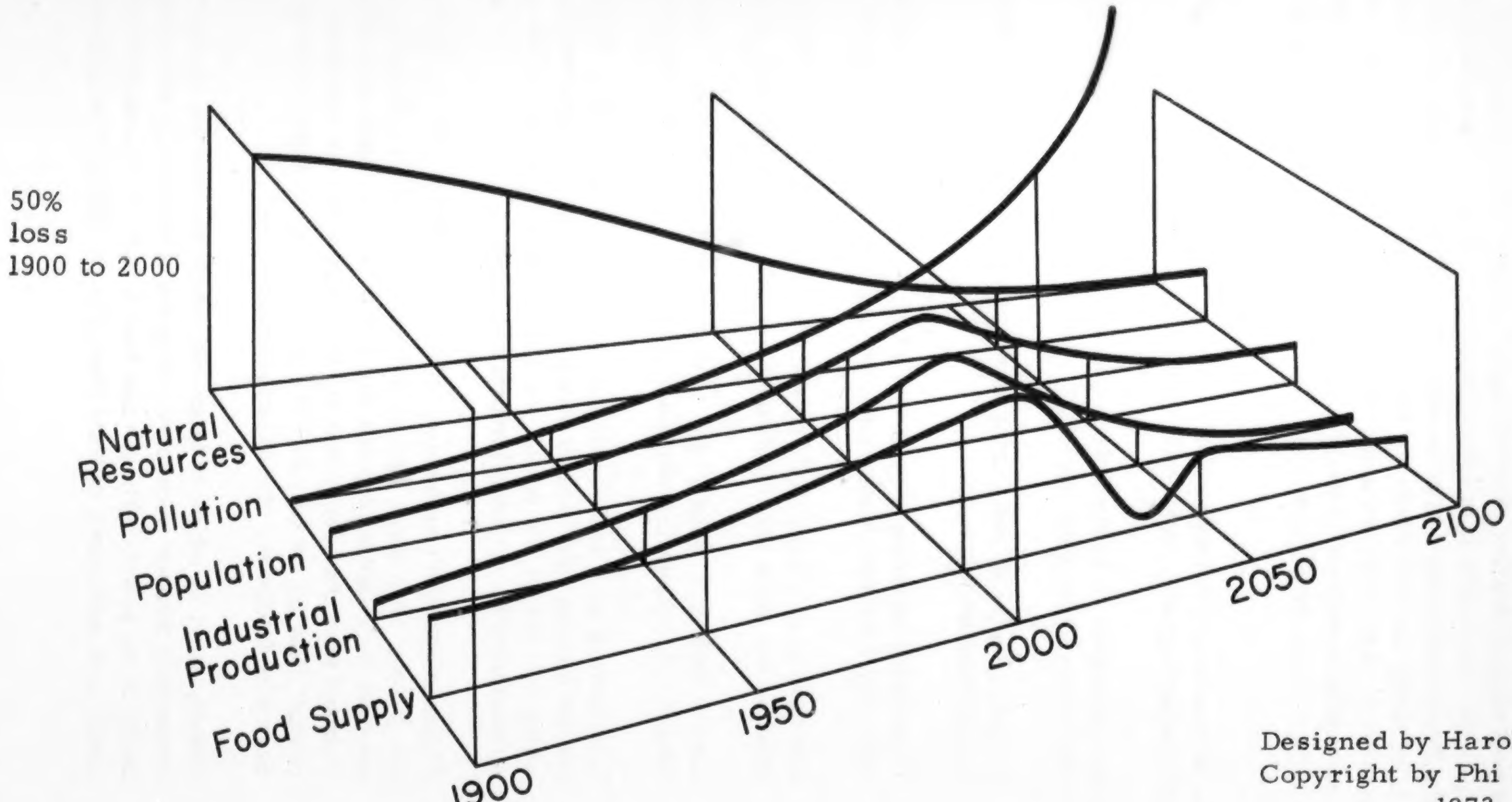
SOME EDUCATIONAL IMPLICATIONS FOR A CHANGING SOCIETY AND ITS SATELLITE CRISES

Since the 1920's five philosophical positions have had an important influence on U.S. education. The proponents of each position contend that they can improve education for tomorrow's world and that their viewpoints, if adopted, will help to reduce the cluster of crises that futures research has inventoried.

Proponents of the **reactionary** or Perennielist position contend that the schools need to return to practices of the past, while **conservatives** or Essentialists strive to retain the present establishment. Educational **liberals** or Progressives want to see recent innovations more widely accepted while the experimentalists or Social Reconstructionists are determined that new and better ideas must be generated within the educational community. Finally there are what for want of a better term we might call the **radicals** or neo-humanists, a mixed bag of theorists whose criticisms range from criticisms of the **status quo** to rather far out propositions for reform such as deschooling and a maze of other alternatives to the present system of U.S. schooling.

Figure I: A Computerized Projection of What Might Occur

Between the Present and the Year 2100 if Present Trends Continue



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Reasoned conjectures of futures research specialists seem to imply that a liberal-experimental position is the most viable of the five identified above.[7] Neither a reactionary return to the past nor a perpetuation of the conservative practices of the present appear to have much promise. On the other hand, the neo-humanist approaches including the deschooling approach, lack traction with reality. In fact, we appear to need alternative forms of education within the precincts of the 1973 educational community rather than extraneous forms of deschooling which ignore the tremendous resources represented by several million teachers and billions of dollars invested in school plants and in important forms of educational technology. These resources simply cannot be poured down the drain.

We turn now to some explicit suggestions as to how, through educational activities and innovation, society may be better able to cope with its clusters of problems.

Some general proposals. In at least two other sources, I have endeavored to present a few representative ways in which education may begin to remake itself.[8]

1) Provision, before as well as after birth, for careful physical and mental examination plus appropriate follow-up.

2) Experiences beginning with birth that promise to create desirable cumulative cognitive input, with methodical schooling beginning no later than at age three.

3) Emphasis on a "personalized" program which concentrates on the learner's optimum development rather than focusing on attempts to bring him up to group norms.

4) Careful efforts to build in the student a positive self-image -- a positive view of himself -- so that he does not feel he is "dirty," "stupid," a "non-reader," and so on.

5) Development of a suitable future-focused role image (FFRI). This is analogous to the self-concept, but extends forward through time to delineate a realistic, motivating concept of the option she has in working toward a life-role that brings satisfaction and promises self-respect and dignity.

6) Endeavor, even with quite young (10-12 year olds) children, to study the "history of the future." Help them through old magazines, books and papers, for instance, to see how the neighborhood has changed in four to eight years. What caused these changes? Were they desirable ones? What was done -- or not done -- to bring about change? How do we go about the task of looking ahead? How does one identify alternative futures and prepare promising scenarios?

7) Identify ways in which children and youth can become of greater value to the community through work-service programs sponsored by the school and involving adults in the vicinity. (The purpose here is again to involve children in some of the useful work roles many of them filled prior to 1920 or 1930 and which gave them a

sense of worth.) Cleaning up litter on beaches or parks or taking care of school clean-up needs are examples of **non-exploitive** jobs in which even six or eight year olds could engage. Older children and youth could perform many more forms of socially useful work, for example by serving as pre-paraprofessionals helping in programs for children of five and under, tutoring other children, handling teaching aids in school, or helping to prepare and distribute food provided through welfare programs. This approach could well eventuate in more widespread postponement of post-secondary education, perhaps decrease the relative number of persons seeking a baccalaureate degree, and more firmly motivate those who do seek to enter a field of work that requires academic credentials.

8) Utilize the community itself as a huge teaching aid by means of which many learnings could transpire. In effect this implies making the community environment not an **alternative** school but a more meaningful **adjunct** to schooling.

Promising changes which suggest themselves with respect to the organizational structure of U.S. schools. A strong rationale can be presented for urging fundamental changes in the conventional graded structure of American education which began to come into fashion in the second quarter of the 19th century as cities like Chicago and their schools together began to grow in a fashion which foreshadowed today's huge metropolitan centers.

Some arguments for change in much of our contemporary practice can be summarized succinctly as follows:

1) Human beings are unique, grow and learn at different rates, have accumulated quite different bodies of experiential input, and have diverse self-concepts and role images with respect to the future. Ergo, schooling should acknowledge the fact of these differences and drop the "impossible dream" of seeking to bring children and youth up to arbitrary and uniform standards of academic and social performance.

2) Learning is continuous and reasons for a nine-month September-June school year have lost whatever validity they once may have had. Ergo, with appropriate physical changes such as air conditioning for schools located in warm areas, we should be able to modify programs to permit children to attend for a total of 180 to 200 days, but spread throughout the year. The actual timing of attendance would be determined by professional judgment, family circumstances, efficient use of the school environment, and the future development of teaching materials that can be used at home.

3) Education, and the need for some type of experiences which schools can provide, extends throughout life. There are human needs at 40, 60, and even past age 70 that are as real as they are at age 5, or 15, or 25. There are needs for new skills as technosocial changes emerge, and for new knowledge in fields in which one studied a quarter of a century before. Also there are the steadily growing challenges of the

> constructive use of leisure, of preparation for post-retirement careers as life spans lengthen, and, of course, for interests and activities that can be encouraged and thus make old age something less to be dreaded.[9]

With this three point rationale in mind, what are some possible changes in structure and in related policies that can be contemplated within the body of the extant educational community? This question brings us to the very heart of the conjectures with which this paper is concerned. It is my thesis that the traditional graded structure needs to be changed so as to permit a lifelong educational continuum[10] of experiencing, learning and self-realizing the extents from early childhood through old age: "...an unbroken flow of experiences planned with and for the individual learner throughout his contacts with the school."[11]

Here are seven basic policies which are an integral part of U.S. schools and their structures which we might well terminate:

1) The practice of chopping education into arbitrary segments - K-6-3-3 or variants thereof, and then trying to figure out how best to "articulate" the pieces of the problem we ourselves have created.

2) The absurdity of annual promotions that assume every child should achieve the **same** level (usually through exposure to the **same** teaching procedures) every academic year.

3) Failure policies and the trauma of flunking grade six or French I; policies which research has repudiated as unworkable.

4) Continuing to assign children to grade levels, a practice which now creates far more problems than it has solved since 1840. Indeed, one of the graded system's greatest sins is its longevity.

5) The use of fixed groupings for reading, general academic ability, and so on; groups into which virtually no child or youth (or adult!) really fits.

6) Our reliance on report cards and grading on which no one agrees and which, again, research has for 30 years or more shown to be both unreliable and quixotic.

7) The increasingly meaningless practice of awarding diplomas or certificates -- except when needed as credentials to establish professional expertise. In an unbroken continuum of learning there is neither a need nor a place for emphasizing segmentation by awarding parchment testimonials.

But the kind of education which contemporary social change requires greatly surpasses the kind of housecleaning suggested by the seven points above. Significant educational reform also extends beyond the reductionism of behavioral objectives, of performance contracting, or criterion-referenced testing and the like. What we need to contemplate are changes such as the fifteen which are described below:

1) **A careful study of what is implied by a meaningful flow of educative input virtually from womb-to-tomb.** This would include various innovations ranging from better problem-preclusive care before birth, to such innovations as old married housing facilities on the campus.[12]

2) **Abandonment of current fixed admission age policies.** It is developmentally incongruous to admit young learners to school only if they were born, say, before midnight on December first in a given year. They should become admissible whenever professional judgment suggests that schooling has a contribution to make to their progress.

3) As a corollary of point two, **discontinuation of any set admission time.** Just as transfer students are accommodated when they move from one district to another during the school year, we should adjust our policies to permit the young to enter a program for three or four year-olds at whatever time they can begin to profit from it.

4) **The present concept of the nine-month academic year should be changed.** New life styles have made tha agrarian school calendar an anachronism. It should be replaced by schools that are open all year long, just as are other institutions such as banks, hospitals or department stores. In its stead a new school year might consist of 185 meaningful days paced to come intermittently over a 12 month interval.[13] New home learning packages, cable and cassette TV and analogous developments in educational technology make the "floating school year" increasingly feasible as do new family vacation schedules which will doubtless increase the frequency of winter, spring and autumn holidays that are beginning to replace the traditional summer family holiday.

5) **Special education, as a separate section of the educational arena should be discontinued.** Rather, all education should be "special." In other words the skills of **special** education personnel need to become a part of the inheritance of all learners. This implies important changes in teacher education.

6) In line with point five, **compensatory education should be terminated** as soon as possible and replaced by **problem-preclusive** educative experiences -- a concept implicit in many of the suggestions made here.

7) **More attention should be given to the concept of supportive education.** Work by Lesser and various multiethnic associates[14] suggests that various ethnic groups (e.g., Chinese, Jewish, Negro, Puerto Rican) display different ability patterns, each group transmitting its own peculiar patterns. Ergo, schools need to begin to capitalize on pluralism and diversity in society.[15]

8) **The current approach to dealing with drop-outs should be modified.** This would involve implementing the lifelong continuum concept modeled on the next page and also elaborated below in points nine through 15. One cannot drop out of a continuum!

9) **There should be no conventional compulsory education beyond age 15 and probably not beyond age 13.** However, **paracurricular** learning would be carefully planned and extended (Cf. point 10).[16]

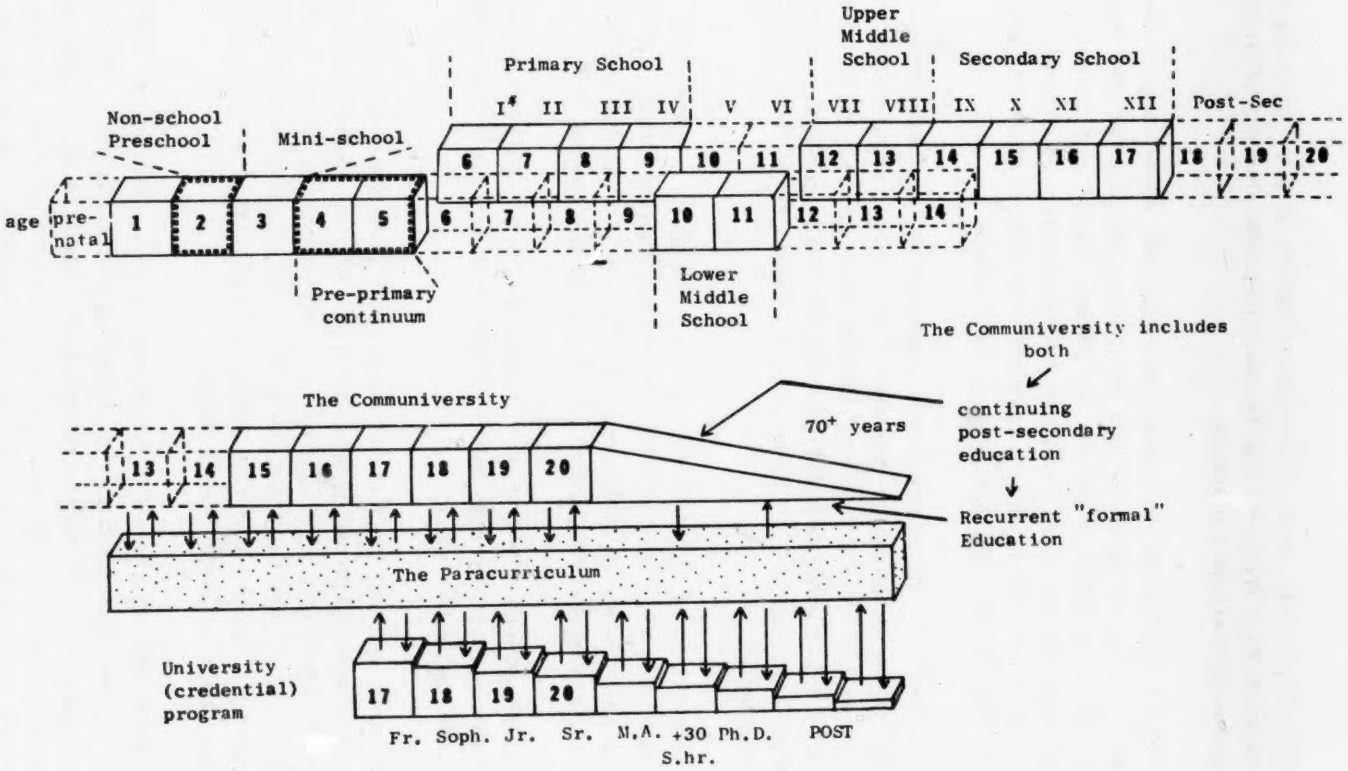
10) **The paracurriculum concept**, as an integral part of a lifelong learning continuum, **needs to be explored and implemented.** "Paracurriculum" refers to the numerous non-school experiences of educational value which learners experience throughout life and which strengthen intellectual potential, cultural and vocational assets and general coping power. (Observe model on the next page.) Presumably the school would participate in planning and in "brokering" non-school paracurricular experiences.

11) An integral part of the paracurricular and continuum concepts would be **planned and articulated lifelong exit and re-entry privileges.** These would need to be carefully orchestrated through enlightened guidance, counseling, especially during the interval prior to the post-secondary segment of the continuum.

12) **Development of the Communiversity Concept,** embodying a "human needs" curriculum in this post-secondary portion of the continuum. This would combine an "open access" interpretation of post-secondary education with respect to the liberal arts. While the trend toward a universalized B.A. (as its prerequisites are now constituted) would be lessened and perhaps reversed, the opportunity for enhanced service to society would be proportionately greater. Wider age groups would be served from today's secondary school to offerings for "mature students" (aged 30 to 60) and for "senior learners" (aged 60 and above). As the model (Figure 2) is intended to imply, learners in the communiversity would have continuing opportunities to move in and out of the "real world" paracurriculum and the credentialing education sequences described in point 13.

13) **Evolving an improved concept of "credentialing education,"** with a variety of programs in such fields as business, law, nursing, education, HPER, medicine and dentistry, music, veterinary medicine, architecture, and so on. As the model suggests,

Figure 2: MODEL OF A LIFELONG EDUCATIONAL CONTINUUM



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one might either enter these professional programs directly from his secondary school experiences or by lateral transfer from the communiversity when comparable prerequisite work has been completed.

14) **An end to the needless and sometimes psychologically debilitating prolongation of adolescence** is also an aspect of the educational changes that may be desirable between 1973 and 1985. Hopefully, the paracurriculum with its diminished academic red tape, and increased flexibility, functioning in close conjunction with the seamless continuum, would lead to fewer campus confrontations, less loss of coping ability and less loss of a feeling of personal significance.[17]

15) Also embedded in the broad reformation suggested here are recent **technical innovations that probably should be extended.** These include computerized retrievable progress records to replace traditional, periodic grade cards for the five-to-eighteens, and a national data bank for facilitating student transfer, to simplify record keeping and perhaps encourage the simultaneous use by the student of the resources of more than one university.

One of the big challenges to new educational models intended for a society that is actively re-creating itself is the task of winning over teachers who are not change-minded. Given dedicated, intelligent administrative and supervisory leadership, I am optimistic that most teachers will not only accept but welcome most of the proposals above. I say this for two reasons.

First, many of the suggestions (the end of a graded structure, and terminating teachers' year-end failures, for instance) are designed to end the teachers' room gripes and complaints I have heard for 30 years. They should be well-received.

Second, the novel continuum and the paracurriculum concept combine to create a new **Gestalt.** They project a new configuration providing educational glue to hold together familiar ideas in a new context. Some of the ingredients glued together included vintage ideas such as: paid internships, socially useful work, continuing education, the year-around school or extended school year, open admissions, and Britain's "Open University." Much of the newness is in the oldness -- but brought into new and potentially meaningful relationships!

New content for 1975-1985. The idea of methods and policies which lead to a personalized educational experience -- a seamless continuum of schooling and education -- needs the added discussion of important and meaningful subject matter. Each learner needs to move at his own speed without reference to group norms; but these personalized norms are mere sounding brass and nothing more unless there is significant input to help the learner in the process of "creating himself."

Since no one is likely to argue against the importance of basic literacy and few would contest the value of communication, social and vocational related skills, let us turn to more subtle nuances of the dialogue in which we must engage with respect to new content for children and youth **and oldsters** in their lifelong educational contacts.

For one thing, education including schooling, must focus boldly and explicitly on the value crisis -- honestly confronting what to do, for example, about the controvertial status of a U.S. which, with six percent of the world's people, consumed over 60 percent of the world's raw material production a year or two ago -- a world in which Ward and Dubos,[18] estimate that, as of 1968, an American baby would consume in 68 years of life **500 kilos** of coal, iron, aluminum, etc., to every **one kilo** a baby born in a mud village of India would consume. Brown[19] cites evidence that he feels could lead to even more uneven distribution of goods by 1990.

For another thing, in view of the declining resources depicted in our first model we may need in our schools and through the mass media to begin stressing the value of:

1) **True-costing**: the idea that to the price of our capital goods, such as autos, we must add the cost of restoring, insofar as we can, the biosphere from which they were wrenched.

2) **Dynamic contraction**: the skills of ending the perpetual "growth" doctrine which suggests that our economic and personal well-being depends on having more and more of more and more things.

3) **Excellence:** products that last and that are engineered to reverse the planned absolescence and the "throw-away society" mentality of which Toffler wrote in **Future Shock.**

4) **Durability**: the idea that satisfactions and self-fulfillment as well as material things need to become stronger; a point closely linked to the doctrine of excellence.

5) **The recycling society**: our need to move from reclaiming perhaps 30 percent of what we use to recycling 99 percent if possible.

6) **A closer look at alternative life styles**: the life styles to be found in some of the 16 types of communes identified by Otto.[20] Among them are the agricultural, nature, craft, art, service and teaching commune.

7) **A service society:** one in which more productivity is obtained from such services as teaching, nursing, social work, paramedical and child care.

8) **Ways of improving our use of mass media:** maximizing the low per-viewer cost of programs such as Sesame Street which operated in 1972 at about one cent per viewer -- and less than that on re-runs.

9) **Re-sensitizing ourselves:** beginning to regain our losses due to crowding, mass production, declining emphasis on social amenities, lack of wide-scale participation in the creative arts and in the performing arts.

Again, there is nothing really far-out or radical in these suggestions. I have found them voiced -- at least obliquely -- by such respected scholars as Walter W. Heller, Kenneth E. Boulding and Barry Commoner.[21]

Perhaps what we need to remember about new content is that much of it may very well become, by 1985, a rewriting by society of what Marcus Aurelius said in his **Meditations:** "What is not good for the swarm is not good for the bee."[22] In a threatened world, we are all threatened, unless each considers the swarm. Here perhaps, are our emphases for the decade ahead.

FOOTNOTES

1. Alvin Toffler. The future as a way of life. Horizons. Summer, 1965, p. 109.

2. Cf. Chapter II in Harold G. Shane. The educational significance of the future. Bloomington, Indiana: Phi Delta Kappa, 1973.

3. Cf. Lester R. Brown. World without borders. New York: Random House, 1972.

4. Cf. Chapter IX in Barry Commoner. The closing circle. New York: Alfred A. Knopf, 1971.

5. Cf. R. Buckminster Fuller. Heartbeats and illions. World. March 13, 1973, pp. 44-45. For an especially gloomy statement, also cf. Philip Wylie's provocative little essay, Why we need poverty to survive, reprinted in the Indianapolis Sunday Star Magazine, pp. 26-28. July 18, 1971.

6. The model in Figure I is an original drawing from the writer's book, The educational significance of the future. Chapter III. It attempts to picture forecasts of what the future might hold if present trends continue until 2100 A.D.

7. For a more explicit and elaborated statement of futurists' views, cf. the opening paragraphs of Chapter IV in Harold G. Shane. ibid.

8. Cf. June Grant Shane and Harold G. Shane. Educating the youngest for tomorrow. in Alvin Toffler, et al. Learning for tomorrow. New York: Random House, 1974. (in press.) Also cf. Harold G. Shane. The educational significance of the future. Chapter IV (three editions), see pp. 92-94 in the original report presented to the USOE.

9. Harold G. Shane. ibid., p. 97.

10. A few of these ideas were first sketched in Harold G. Shane. A curriculum continuum: Possible trends in the 70's. Phi Delta Kappan. 51:389-392. March, 1970.

11. Loc cit.

12. Last year (1971-1972) a post secondary program in Minneapolis drew four times the anticipated enrollment of persons between 58 and 82 years of age. Representative course titles: "How to Live on Social Security Payments" and "Sex after Sixty."

13. This obviously implies concomitant changes in staff deployment.

14. Jane G. Fort, Jean C. Watts, and Gerold S. Lesser. Cultural background and learning in young children. Phi Delta Kappan. 50:386-388. March, 1969.

15. Ibid., p. 388.

16. Patently, great care would need to be exercised so that, say at age 14, the adolescent would cycle and recycle from curriculum to paracurriculum without stigma and without encountering academic or social problems. Also proposal number nine does not presuppose that we discourage wholesome learning in extant schooling facilities, but their more flexible use over larger age spans.

17. There was a tragic and needless barrier between youth and older adults during the 1960's. The kinds of reforms intended here are designed to put both young and old together on the same side of a barrier against the real enemy of both: the world's plagued ecosystem and its population problems, the maldistribution of goods, and the need to learn a more disciplined approach to the use of technology.

18. In Only one earth. (See bibliography.)

19. Lester R. Brown. World without borders. Cf. bibliography. He, of course, deals with what could be, not with what will be. Linear projections often are misleading.

20. Herbert A. Otto. Typology of communes. The Futurist. 7:112. June, 1973. Also see his article, The alternative life style. Saturday Review. April, 1971.

21. Cf. Sam H. Scharr, ed. Energy, economic growth, and the environment. Baltimore, Md.: The Johns Hopkins University Press, 1972.

22. Meditations. VI, c. 170.

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FUTURE OF TECHNOLOGY

TECHNOLOGY IN THE FUTURE OF EDUCATION

by

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INTRODUCTIO

This paper will focus upon two main subjects; namely 1) near-term (next five to 20 years) development of technology for education and 2) the extent to which that technology will find use in school systems. These subjects have been of concern to us at the Center for Development Technology in our efforts over the past few years to examine opportunities for utilizing communications technology in education, to synthesize hypothetical educational delivery systems and to assess the potential impact of such systems.

The paper is divided into four main sections. First, a number of recent articles and reports are reviewed which provide a broad overview of hardware and technology-based delivery systems for education. This is followed by our own examination of educational television and radio, cable systems, communications satellites, videocassette recorders and portapaks and computers. The emphasis is upon the technology itself, the extent to which it has been utilized in education in the past, and factors which might influence future utilization. In contrast to information available on the technology, there is a dearth of information on the extent to which the technology is actually being utilized by school systems. There have been relatively few attempts to forecast the future use of technology in education or to analyze those forces at work which might affect future utilization.

A third section presents results obtained by Robinson (1973) of a recent Delphi forecast of technology in education in the years 1980 and 1990. The forecast includes not only levels of utilization but also values and opinions in the year 1990 which might affect utilization. The paper concludes with some remarks concerning the use of educational technology to improve productivity of school systems.

TECHNOLOGY FOR EDUCATION: REVIEW OF RECENT STUDIES

Ohlman (1971) has provided a fairly comprehensive survey and analysis of the present, i.e. 1971, state and future trends of communications media and educational technology. Separate chapters of his work are devoted to still-picture media for instruction, computer-assisted instruction, educational communications satellite systems and electronic versus physical distribution of educational materials. In this latter chapter, major sub-sections examine facsimile systems, micro-imaging systems, wired television systems and cassette and disc program storage systems.

Ohlman perceives an overall trend towards replacement of physical means of distribution by electronic means, citing the relatively rapid growth and profitability of telephone versus the postal service in the U.S. He is enthusiastic about the still-picture medium for many learning situations and sees the TICCIT system as a promising approach to development of computer-assisted instruction. Video cassettes are described as having the potential to become as convenient for sight as audio cassettes are for sound, provided that compatibility of equipment is achieved among various systems being or about to become marketed. Future marriages of microfilm with both television and computers are seen as having important future educational uses.

Ohlman also comments briefly on factors affecting future utilization. He finds the introduction of instructional technology into U.S. schools, with few exceptions, to have been "uncoordinated, ineffective and piecemeal (p. 185)." Broad support from teachers, administrators and the public, long-term commitment from school boards and the establishment of instructional technology on an "integrated, total-systems basis (p. 185)" are called for if educational technology is to become more effective. Media diversity is seen as essential "if a wide variety of student characteristics and instructional situations are to be served in an economical manner (p. 185)." Studies are recommended to gain an understanding of the characteristics and limitations of various types of media as well as to determine costs of various alternative delivery methods for instructional programming.

Korman (1971) examines and projects trends for future development of the following services for education: Educational Television, Closed-Circuit Instructional Television, Instructional Television Fixed Service, Video Tape Recording - Video Cassettes, Satellites, Cable Television, Radio, Telephony and Information Networks. Among the current trends Korman sees in hardware are microminiaturization of equipment and information; increased message transmission capacity; two-way (interactive) information flow; more complex and complete information grids; faster and longer-distance communications; multi-media use of technologies. Trends in software include: self-paced instruction, interdisciplinary instruction, greater student involvement as an active learner and element in learning environment design, increased stress on relevancy in the educational process, changing teacher roles (concepts) such as team teaching and more scheduling flexibility for instruction.

Recently, Jamison, Suppes and Wells (1973) have reported on a survey they undertook to provide an overview of research on the effectiveness of alternative instructional media. The media considered were traditional classroom instruction (TI), instructional radio (IR), instructional television (ITV), programmed instruction (PI), and computer-assisted instruction (CAI). Achievement test scores were the measures of effectiveness most frequently used. It is concluded that "students learn effectively from all these media, and relatively few studies indicate a significant difference in one medium over another or of one variant of a medium over another (p. 52)." However, the authors point out that the present state of the literature is preliminary in nature as far as providing a basis for deep understanding of the strengths and weaknesses of technological laternatives to traditional instruction.

Considerations of probable importance singled out by Jamison, Suppes and Wells (1973) for extensive study in the future include: examination of whether savings in time exhibited in some studies using PI or CAI can be shown to be significant over longer periods and for a larger proportion of the total instructional program of students; more detailed evaluation of impact of various technologies on long-term student motivation; long-term effects of individualized instruction inherent in some technologies; examination of new media uses which may break from the previous mold in which the medium is used as an imitative substitute for the teacher.

In the title of a provocative article, Koerner (1973) asks, "Educational Technology: Does it Have a Future in the Classroom?" and then answers his question with a "maybe." He likens asking about the future of educational technology in 1973 to asking in 1903 about the future of the aeroplane. Koerner points out that a great deal of educational technology exists in the form of hardware which does not meet the demands for access, individualization and economy in education. To respond to these demands being made on the educational system becomes a possibility only if educational technology means something more than hardware: "an integrated system of teaching and learning for which the cost is reasonable and for which software has been specifically developed, tested in practice, revised, retested and finally validated...(p. 45)."[1]

Koerner boils the major technological elements down to five; **broadband communications** in which by means of coaxial cable, microwave and satellites today (lasers, glass fibers and other exotic devices in the future), "we have the capability of creating many kinds of telecommunications networks with more or less unlimited capacity. These networks could tie educational institutions together as well as tie them to other kinds of public institutions and directly to homes (p. 45);" **computers** which offer the educator "a means unmatched by anything else he has ever had available for the lightning processing of truly vast amounts of information (p. 45)." Two major CAI experiments, TICCIT and PLATO will produce "within another three or four years better data about computer learning than we have had in the past (p. 45);" **video reproduction** represented either by videotapes and cassettes or in combination with broadband communications; **miniaturization** including such extreme reductions as the 20,000 volume library on American civilization now offered by Encyclopedia Britannica on 20,000 fiche each measuring three by five inches; **books, blackboards and others,** including radio.

Armsey and Dahl (1973) prepared a report entitled "An Inquiry Into the Uses of Instructional Technology" published by the Ford Foundation, an organization which has been heavily involved in the development of educational television in the U.S. and to some extent in other countries. The report contains a useful overview of the "things of learning" which are believed to have the potential to make a significant quantitative or qualitative difference in education. Included are television and television-related technologies, film, audio-tape, radio, programmed instruction and means for its presentation, computers and books. Included are brief descriptions of how each technology works, how they have been used and with what effect in furthering learning and education in the past. Suggestions are made concerning promising uses in education and possible obstacles. In general, no cost estimates are attempted although it is stated that costs of producing effective educational programs in money, skills, testing and revision, and time have been consistently underestimated. The section on television describes various videotape, cassette and disc devices, cable transmission and satellite transmission among others.

Armsey and Dahl identify the following factors which have tended to impede effective use of instructional technology: confusion concerning definitions and objectives; teacher resistance; the "hardware-software dichotomy" in which software lags behind hardware; the lack of conclusive research and evaluation. A concluding chapter outlines conditions believed necessary by the authors to achieve success in utilization of instructional technology; existence of recognized and generally agreed-upon needs; a pervasive desire to meet the need through the use of instructional technology; the existence of a well-articulated purpose to guide the project; the existence of a structure to make success possible or at least not assure failure in advance; leadership at the right level of authority; responsibility and control (strong backing at the top is cited as a basic requirement for swift innovation in a school system), teacher participation and support; the existence of some substantive need for the use of "the things of learning;" a mechanism for measurement and evaluation; adequate resources throughout the project.

TECHNOLOGY IN EDUCATION

Educational Television and Radio

The media most familiar to students and teachers, and likely to be important elements in the future of technology in education are television and radio. The adjective **educational** when used with these nouns is often taken to encompass both **instructional** and **public** television and radio. **Instructional** usually refers to the use of these media for instruction within a formal school setting or instruction which leads to some form of certification. **Public** came into use with the creation of the Corporation for Public Broadcasting and usually connotes cultural enrichment. However, the distinction between **public** and **instructional** becomes blurred as the Public Broadcasting Service begins to distribute television programs such as "Electric Company" which are viewed within formal school settings.

A study by DuMolin (1971) indicates that there appears to be few reliable data on the extent to which instructional television and radio are used in classroom settings. What data there is (and it is somewhat dated) suggests that a relatively small percentage of classroom time (less than 5%) is devoted to watching television. Causes of this situation include lack of quality programming, inflexibility in scheduling, teacher resistance, and lack of resources when technology utilization represents an add-on cost. There is a dearth of literature which documents successful examples of ITV and IR use, particularly from a cost-effectiveness point of view. A recent study by Jamison and Klees (1973) carefully analyzes costs of instructional radio and television for developing countries, but equivalent analyses do not appear to be readily available for the U.S.

Of the delivery systems for ITV, two that have found use are closed- circuit TV (CCTV) and broadcasts by educational stations or via educational networks. Closed-circuit TV installations generally rely heavily on local programming although the trend seems to be away from local programming and towards using national distribution mechanisms such as NIT and GPNITL.[2] Washington County, Maryland and Dade County, Florida are often cited as being successful examples of use of closed-circuit TV in school systems. Detailed cost-effectiveness[3] and/or cost-benefit studies for these systems would be of considerable interest to educational planners. A variant of CCTV is the Instructional Television Fixed Service, which is utilized heavily by parochial schools. Extensive information about various educational electronic broadcast services can be found in a report by Singh and Morgan (1971a).

Some schools are tied together in state instructional television networks, South Carolina being a leading example. DuMolin (1971) reports that in South Carolina as of 1970, ITV had gradually assumed the major responsibility for instructional content for mathematics in grades 4-12 and physical sciences in the high school. Interstate educational networks (e.g., Eastern Educational Network and Southern Educational Communications Association) have been formed to facilitate sharing among states in various regions.

With the advent of a delivery system for educational television and radio that is national in scope through the creation of CPB, PBS and NPR,[4] both new opportunities and new problems were created. Through a nationwide interconnection, about 200 ETV outlets are able to carry programs with the potential for reaching some 74% of the U.S. population. One program designed to teach basic letter, number and other skills to pre-schoolers, namely Sesame Street, has provided an impetus for renewed interest in public television, stirred a lively debate about pre-school educational strategies and provided educational researchers with a wealth of data with which to attempt to evaluate cost-effectiveness of television in education. The program illustrates the way in which quality programming can be produced and distributed at extremely low per-viewer costs, reported by Rothenberg (1973) as $1.29 per pupil, provided that a large-scale distribution system exists to achieve economies of scale.

Still another step was taken with the development and distribution of "The Electric Company," a program designed to teach reading skills, which is usually done within a grade school setting. The program is broadcast in some areas twice a day, and one of these broadcasts occurs during school hours. The manner and extent to which Electric Company programs are utilized in school systems should be carefully analyzed.

The widespread, rapid impact of Sesame Street and Electric Company was made possible by the existence of a large-scale organizational framework for delivery, namely public television. Whether future developments of this kind can be expected depends upon the future of public broadcasting in the U.S. Key issues yet to be fully resolved include: decentralized versus centralized control; long-term versus short-term financing; independence versus political interference. If public broadcasting can emerge from these battles in a cohesive way with firm financial support free from government interference, it seems reasonable to expect that public television will wish to become more heavily involved in instructional broadcasting, using regional or national consortia[5] to co-operate in program production.

Relatively little has been said about radio here, which perhaps typifies the way in which it has been neglected in the U.S. as an instructional medium. It has been used with good results in many places, including the St. Louis public schools. National Public Radio exists to provide an organizational framework for national delivery. Radio is relatively inexpensive, ubiquitous and worthy of more attention than it has yet received.

Two delivery mechanisms which could potentially play an important role in increasing the use of television and other media in education are cable systems and communication satellites. The former might provide for more flexibility in program scheduling and more variety, whereas the latter could extend the reach of television and other media to rural and remote areas. Each of these will be considered in turn.

Cable Communication Systems

Cable television, often called Community Antenna Television (CATV), began as a minor adjunct to the present system of over-the-air broadcasting in the late 1940's to bring distant TV signals to areas which did not have any coverage. Now it is on the verge of becoming a major communication medium in its own right. A system that was developed to provide TV coverage to small towns in wide and sparsely populated areas is believed by some to have set the stage for a great communications revolution in major metropolitan and urban areas -- a revolution associated with the coming of broadband communication networks (BCN) or the beginning of a "wired nation" (Smith, 1970).

As of the end of 1972, cable television (CATV) systems served at least 10% of U.S. homes (Neal, 1973). Projections indicate rapid expansion of CATV in the U.S; some studies project CATV penetration to reach as many as two-thirds of TV homes by mid 1980's (Neal, 1973; Sloan Commission on Cable Communication, 1971). In the top 100 TV markets, new systems (and old systems by March 31, 1977) are required to provide capabilities for at least 20 channels (FCC, 1972). In small communities with populations less than 10,000, the economic base seems to be insufficient to support more than 12 channel systems (Rickel, 1972).

The Federal Communications Commission (FCC) has ruled that return communication on cable systems, at least on a non-voice basis for certain narrow band services like meter-reading, is now demonstrably feasible and has required that cable systems be constructed with the potential of eventually providing return communication without having to engage in time-consuming and costly system rebuilding (FCC, 1972). Such capability has the potential for promoting new interactive education services such as delivery of computing power to homes, learning centers and schools from a centralized source; "talk-back" television to provide interaction with a remotely located instructor; computer-assisted instruction (CAI); and educational information systems (EIS) implemented on an inter-school basis. A number of interactive television and data-file based inquiry systems have already been developed with cable-based delivery in mind. One such system, of considerable significance from the viewpoint of educational applications, is the TICCIT (Time-Shared, Interactive, Computer Controlled Information Television) under development at the MITRE Corporation under NSF sponsorship (Stetten and Rodney, 1973).

The extent to which education will capitalize on cable communications systems, which are developing primarily commercially, is uncertain. The FCC (1972) has ruled that cable operators must make available for educational purposes at least one channel in the major markets. Two other channels must be designated for public access and government uses. This is only for a period until 1977 when it is conceivable that, as FCC Educational Commissioner H. Rex Lee is cited in a recent Newsletter (JCET, 1973, p. 8) as having stated that they must be used or lost. Our general impression is that there is a great deal of interest in the public access channel on the part of various groups. However, the depth of interest on the part of school systems may be less strong.

Part of the problem is that one additional channel may not improve the capability for delivering media to the schools or flexibility in using these media to any great extent over present capability. On the other hand, imaginative uses of cable systems dedicated solely for educational purposes could make a marked difference. Barnett and Denzau (1972) have set forth some options for dedicated educational cable systems and have provided cost estimates. They found that a 40-channel dedicated educational cable connecting all schools to a district head-end could provide TV instruction for an average of 20 percent of classroom time at a cost of about two percent of the average school budget (p. 2). Such systems can provide multiple showing of the same programs so that the teacher has considerable flexibility in scheduling, although this flexibility is not as great as when videotapes are employed in each classroom.

In a booklet put out by the Division of Educational Technology of the National Education Association (1971), Wigren quotes the position on cable television taken by the NEA Representative Assembly at their 1970 annual meeting:

> "The National Education Association believes that the use of Community Antenna Television (CATV) channels for education is essential to preserve the public interest, to afford an opportunity for educational innovation and to encompass the learning needs of a diverse society.
>
> The Association directs its officers and staff to seek the reservation of at least 20 percent of all CATV channels for educational purposes (Current Resolution 70-25, p. 1)."

It would appear that in designating only one channel for education, the FCC was considerably less responsive than NEA desired. The Commission did, however, require two-way capability which NEA felt was especially important in planning for instructional uses of cable systems. However, it should be noted that existing and developing two-way systems are currently considerably more expensive than one-way systems.

Communication Satellites

Fixed and broadcast communication satellites[6] represent another technology which holds forth promise for use in education, particularly for information networking over long distances and delivery over wide areas. In contrast to the "single-route, fixed capacity" characteristic of terrestrial interconnection systems, fixed/broadcast satellites offer a "multiple-route, allocable-capacity" capability which allows for many new wide-area services in addition to those available from terrestrial systems in the past.

An international satellite system, INTELSAT, has been in existence since 1965. In the near-term future, we will see development of a number of domestic satellite systems in the U.S. Even though these satellite systems are primarily designed to provide fixed satellite services with relatively large ground terminals, they are likely to offer substantially reduced rates for long-distance telecommunications. For example, today a private voice circuit between Los Angeles and New York costs approximately $2,400 per month if leased from AT&T; American Satellite Corporation has proposed a rate of $1,200 per month for a similar line.

High-power fixed or broadcast satellites capable of interconnecting low-cost and small terminals located at user facilities represent a further development in satellite technology. NASA's Applications Technology Satellite-F and the joint Canada-NASA Communications Technology Satellite (CTS) will be used in experiments to demonstrate the feasibility of such a service in the 1974-77 time-frame. However, there are currently no plans for an operational service of this kind.

Whereas cable television is usually of local concern, educational delivery systems which are hypothesized utilizing satellites generally require consideration of regional, national or even international organization and administration. Walkmeyer (1973) has analyzed the organizational problems associated with such systems which are very complex, in view of the essentially local or decentralized nature of education in the U.S.

In a booklet published by the National Education Association entitled "Man-Made Moons: Satellite Communications for Schools (1972)" some of the promise held forth by satellites is presented. Future experiments and policy questions are discussed. The NEA supports reservation of satellite space for educational purposes and encourages carriers to give preferential treatment to education.[7]

Once again developments have been somewhat less than NEA might desire. Propelled primarily by commercial development, a generation of satellites is about to come into being which was designed with little or no concern for educational interests. Of the six domestic satellite systems approved as of October 1, 1973, by the Federal Communications Commission (FCC), only one, National Satellite Services, Inc. (NSS), a subsidiary of Hughes Aircraft Company, has been directed by the FCC to provide free facilities for public broadcasting. No free services appear to be available to other educational users.

As in the case of cable TV, incremental gains in capability such as one more ETV channel or one satellite channel[8] in a domestic satellite may be very appealing to educators, and the cry may then go up that they are uninterested in using the technology. The problem is that the technology and the system for delivery were never designed to meet the needs of the educator. Satellites may very well serve to interconnect cable television head-ends and ground microwave systems designed for commercial use in the not-too-distant future, but this may be of little value to school systems. However, properly designed and supported, such an interconnection could aid in providing a second public broadcasting system, or an alternative educational telecommunications system which is national in scope.

Satellites could serve to bring more educational resources to rural and remote areas provided that they have sufficient power to reach relatively inexpensive terminals. The proposed commercial domestic satellites, scheduled to become operational shortly, do not have this capability. Television with talk-back, radio, data transmission and CAI are but some of the services which can be transmitted via satellite. Such transmissions for health and education are to take place in 1974-1975 in the Rocky Mountains, Alaska and Appalachia using a high-power, Advanced Technology Satellite, ATS-F. Educational and communications experiments are also planned with the Communications Technology Satellite (CTS), a joint U.S.-Canada project which is scheduled for launch in the fall of 1975. However, a recent decision by NASA to phase out communication satellite development work is likely to seriously inhibit the future development of educational satellite systems, unless other federal agencies expand their activities. The economies of scale with satellites are such as to require regional and inter-regional cooperation which seems best promoted by federal assistance and R&D.[9]

Videocassette Recorders, Portapaks, Etc.

Devices such as videocassette recorders and portapaks seem to offer a maximum of opportunity for creative involvement by individual teachers and students. Barnett and Denzau (1972) have recognized the great flexibility of videotapes and have provided costs for two systems: one in which each school has one mobile TV set and VTR per five rooms; the other in which there is a TV set and VTR in each classroom. They feel that the VTRs are more likely to be accepted by teachers than other technologies because they can control their use. Hence the primary purpose of the first of these two systems is for experimentation and learning by classroom teachers. In their expanded system, such devices can be "networked" through mailing of tapes although tape costs and storage are important economic factors. However, the cost of the expanded videotape system is estimated to be more than twice that of a 40-channel cable system (p. 33).

Computers

Computers are used in education for research, administration and instruction,[10] primarily in higher education. However, below this level, there has been considerable usage, particularly for administrative purposes in secondary schools. Although instructional usage seems to attract the most attention on the part of educators, the impact of computers on educational administration seems worth examining within the framework of school system productivity.

As far as computer-assisted instruction is concerned, there is currently relatively little utilization in school systems. A recent study by Anastasio and Morgan (1972) has identified the following factors to explain this situation: 1) an inadequate system for software production and distribution; 2) lack of demonstrations of CAI and efforts to convince people that CAI is cost-effective; 3) an absence of adequate theories of instruction on which to base CAI systems; 4) the need to change the traditional roles of teachers so as to take advantage of CAI; 5) high costs of CAI; and 6) a need for technological research and development.

Two major CAI demonstrations are currently being implemented; one using the large and highly centralized Plato-IV system (Programmed Logic for Automatic Teaching Operations) developed by the University of Illinois, the other, the TICCIT (Time-Shared, Interactive, Computer-Controlled Information Television) system developed by the MITRE Corporation. Although these systems differ considerably in their technical characteristics and capabilities, they have a common objective of providing CAI services at costs commensurate with those involved in teacher-administered instruction. In contrast to the $5.85 student-hour costs for CAI instruction quoted for a college level physics course for the period 1965-1969 with commercially available systems (Hansen et. al., 1968), Plato-IV is estimated to cost $0.34 per student-hour (Blitzer and Skaperdas, 1969) while the combined monthly charge for TICCIT and basic services is estimated in the range of $19.50-$24.20 (Stetten and Rodney, 1973).[11]

Plato-IV is designed to serve 4,000 specially designed terminals with a plasma display panel and with memory provided by a centrally located, single large computer. TICCIT connects a small computer to home television sets via cable systems, using the TV set as a display device, a small video-recorder/player as a frame-grabber, and a touch-tone telephone pad for interaction via the phone system. These demonstrations, along with other CAI work in progress, should provide useful information on the future potential of CAI in schools, although a major part of the effort is directed towards use in junior colleges and institutions of higher learning.

CAI poses a real dilemma for educators and school systems. If it is true that large-scale CAI systems will some day achieve a per pupil cost less than that of traditional instruction, and if it is true that students can learn certain subjects faster with CAI, just how do we get from where we are today to where we'd like to be in the future. CAI systems would seem to be incompatible with the kind of lock-step, graded schools we have today. CAI use may be more at home in other kinds of non-traditional situations. As far as large-scale replacement of teachers by computers is concerned, such a development seems neither possible nor desirable.

Concluding Remarks

The publication **Urban Telecommunications** (May, 1973) reprinted a chart illustrating the time line of developments in information and communication technology through the year 2000. Predicted are a 100-fold decrease in computer costs between the years 1983-1997. Development of computer technology and communications technology becomes merged and laser transmission, fully digitized telephone networks and home videocomputers come into being between the years 1980 and 2000. Both highly personalized audio/video tape cassette systems and highly sophisticated nationally and internationally linked computer-communications systems using satellites provide one-to-one communication. Flat-screen wall television and 3-D television emerge. Long distance systems communications capacity increases greatly. Past experience would indicate that computer and communications technology will continue to develop at a rapid pace in this century. Predicting the extent to which such developments will be used in school systems is a much more difficult undertaking.

A DELPHI FORECAST OF TECHNOLOGY IN EDUCATION

Robinson (1973) has recently completed a study using the Delphi technique with the objective of forecasting the future use of technology in education. Quantitative predictions of utilization were made for the years 1980 and 1990 for three classifications of technology: 1) television instruction, 2) computer instruction and 3) information services.[12] The emphasis was upon large-scale educational telecommunications technology -- that technology which could be organized for distribution through large systems and networks. Six categories of education were used: 1) early childhood education, 2) primary and secondary education, 3) higher education, 4) adult and continuing education, 5) vocational and technical education and 6) special education. Robinson also forecast values and opinions for the year 1990 concerning education and constructed a scenario of what education in 1990 might be like.

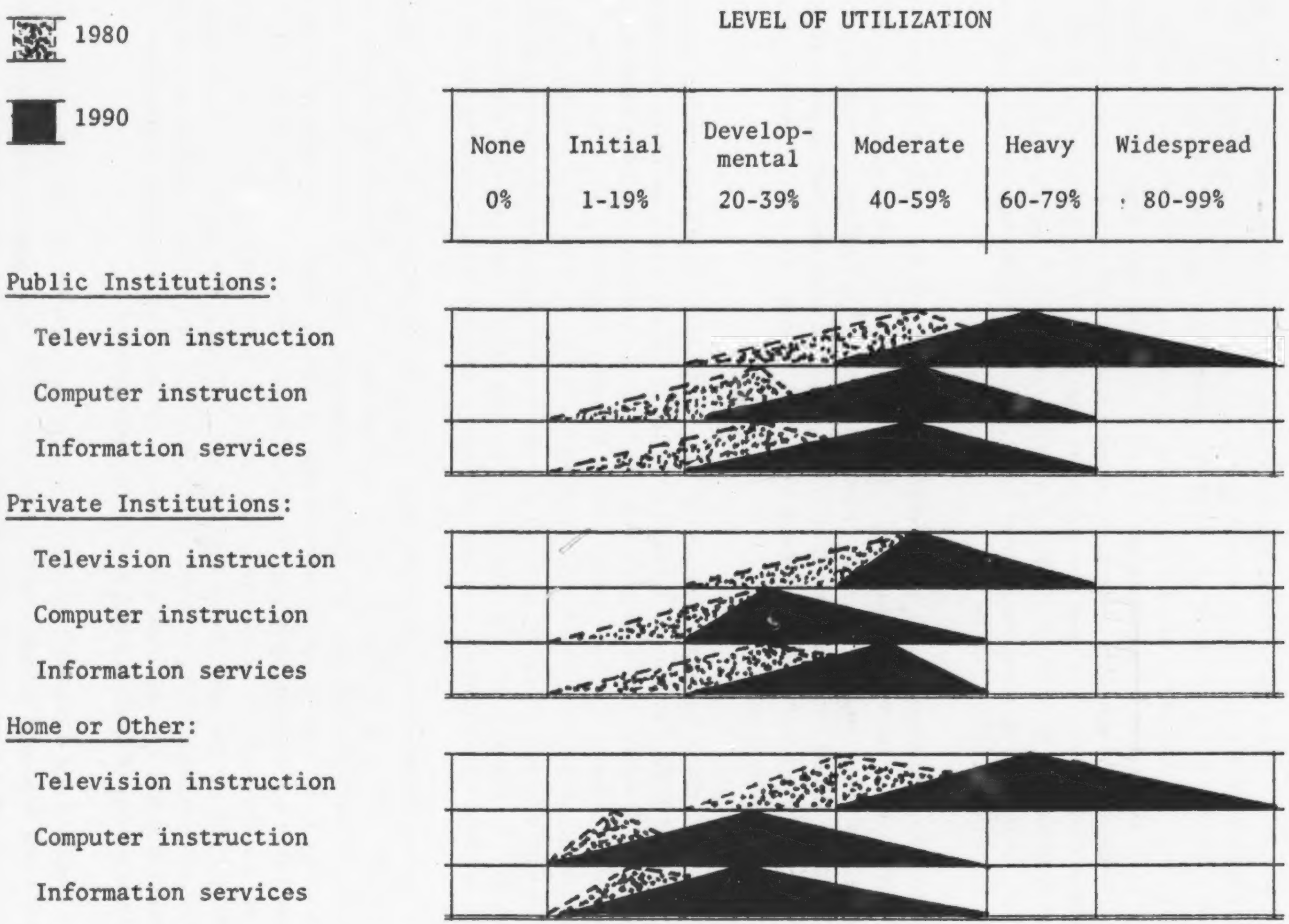
Robinson points out some of the limitations of such a Delphi study. Although a fairly representative panel of participants was sought, the majority of respondents were communications technologists and educational planners concerned with the use of technology and telecommunications in education. Teachers and school administrators generally seemed reluctant to participate. The forecasting problem is a difficult one because of the lack of information on current utilization and the many social forces at work.

Figure 1 shows the predictions of the level of utilization in primary and secondary education by 1980 and 1990. Television is the medium of widest use in public institutions, private institutions and homes. The bulk of the utilization appears to be in the developmental to moderate range, with computer instruction and information services somewhat lagging for use in the home.[13] It should be pointed out that Robinson's utilization figure measures the percent of locations in which the technology is in educational use and not the extent of utilization in those locations. Therefore, it does not, for example, provide information on how many hours television is viewed in the classroom or home. Such information would be needed in defining inputs for productivity studies.

Figure 2 summarizes results of values and opinions of people in 1990 as determined by Robinson's study. Of particular interest to those concerned with productivity are responses to statements seven through ten. The strongest acceptance seems to be for combining teachers and technology to do a better job at the same cost, or slightly lower on the acceptance scale, to do a better job at a somewhat higher cost. There is slight acceptance of replacing teachers by technology to do the same job for considerably less cost, and slight rejection of replacing the teacher by technology to do the same job for the same cost. Although these opinions are at too general a level to be useful in productivity analyses, they provide food for thought, nevertheless. It should be kept in mind, however, that these values and opinions reflect the viewpoints of the panelists in this study and that a group of teachers might have responded differently.

Figures 3 and 4 present forecasts concerning organizational structures for large-scale delivery systems and large-scale software supply systems in 1990. There appears to be no dominant element in many of the aspects probed, although public control and financing for delivery systems seem to

FIGURE 1: UTILIZATION OF TECHNOLOGY IN PRIMARY AND SECONDARY EDUCATION*



*The triangle represents the middle 50 percent of the responses for the appropriate year, the peak being the median response.

FIGURE 2: VALUES AND OPINIONS OF PEOPLE IN 1990[†]

1 strong rejection	2 moderate rejection	3 slight rejection	4 neutral	5 slight acceptance	6 moderate acceptance	7 strong acceptance

PUBLIC OPINION POLL (of people in 1990)

1.	The federal government should determine the content of educational software.	$\underline{1\quad\textcircled{2}}\quad 3\quad 4\quad 5\quad 6\quad 7$
2.	The development of educational data banks of grades, test scores and personal information on students should contain adequate safeguards to protect the privacy of individuals.	$1\quad 2\quad 3\quad 4\quad 5\quad \underline{6\quad\textcircled{7}}$
3.	The individual student should have access to the information about him which is stored in educational data banks.	$1\quad 2\quad 3\quad 4\quad \underline{5\quad\textcircled{6}\quad 7}$
4.	Educational institutions should be held accountable for the educational methods they use and results they obtain in terms of quantifiably measurable outputs (e.g., using PPBS, PERT, and other productivity measures).	$1\quad 2\quad 3\quad 4\quad \underline{5\quad\textcircled{6}}\quad 7$
5.	If initial costs of implementing educational technology are high, federal or regionally shared money should be used to pay initial costs for poorer schools.	$1\quad 2\quad 3\quad 4\quad 5\quad \textcircled{6}\quad 7$
6.	In an attempt to equalize educational opportunities, educational technology should be used in richer schools to generate savings which could be used to improve poorer schools.	$1\quad \underline{2\quad\textcircled{3}\quad 4}\quad 5\quad 6\quad 7$
7.	If educational technology can do the same job for the same cost, it should be used to replace the teacher.	$\underline{1\quad 2\quad\textcircled{3}\quad 4}\quad 5\quad 6\quad 7$
8.	If educational technology can do the same job for considerably less cost, it should be used to replace the teacher.	$1\quad 2\quad \underline{3\quad 4\quad\textcircled{5}\quad 6}\quad 7$

[†] Underscoring represents the middle 50 percent of the responses, the circled number is the median response.

FIGURE 2: VALUES AND OPINIONS OF PEOPLE IN 1990 (continued)

9. If the combination of educational technology and teacher can do a better job at somewhat higher costs, the combination should be used. 1 2 3 4 5 [✓ 6] 7

10. If the combination of educational technology and teacher can do a better job at the same cost, the combination should be used. 1 2 3 4 5 6 [✓ 7]

11. Para-professionals, student teachers, multi-media technologists, and teacher's aids should be accepted as important and necessary components of the educational process. 1 2 3 4 5 [✓ 6] 7

12. Educational technology should be looked upon by teachers as a threat to their job security or an infringement upon their classroom control. 1 [✓ 2] 3 4 5 6 7

13. Assuming it is true that technology creates feelings of alienation, deindividualization or dehumanization, then it should be kept out of education, no matter what the learning benefits are. 1 2 3 [✓ 4] 5 6 7

14. Curricula should contain significant amounts of non-academic (experiential) items and should remain highly flexible in content. 1 2 3 4 [✓ 5] 6 7

15. Assuming that educational technology cannot effectively transmit certain socialization and cultural values, methods and institutions similar to those in 1973 should be maintained to accomplish these purposes. 1 2 3 4 [✓ 5] 6 7

16. National or regional degree-granting organizations should be created to relieve the job of certification and degree-granting from educational institutions. 1 2 3 [✓ 4] 5 6 7

17. Schools should continue their "custodial functions" (i.e., babysitting children during the day and keeping them out of the labor force). 1 2 3 4 [✓ 5] 6 7

18. With the aid of technology, educational institutions should be better able to define their goals and functions. 1 2 3 4 [✓ 5] 6 7

19. Standardized programming should be avoided because it produces a bland and sterile, mass education. 1 2 3 [✓ 4] 5 6 7

FIGURE 2: VALUES AND OPINIONS OF PEOPLE IN 1990 (continued)

20. Education should be thought of as something which extends throughout a lifetime, with individuals leaving and returning at various times in their lives. 1 2 3 4 5 6 [✓ 7]

21. Copyright laws should protect an author's rights for instructional materials which become part of a computerized software system 1 2 3 4 5 [✓ 6] 7

22. Copyright laws should enable the freest possible access to instructional materials by students and teachers. 1 2 3 4 5 [✓ 6] 7

23. The socio-economic background of a student should determine the kind of educational opportunity provided to a student. [✓ 1] 2 3 4 5 6 7

24. Educational programming should incorporate elements of entertainment into its material. 1 2 3 4 5 [✓ 6] 7

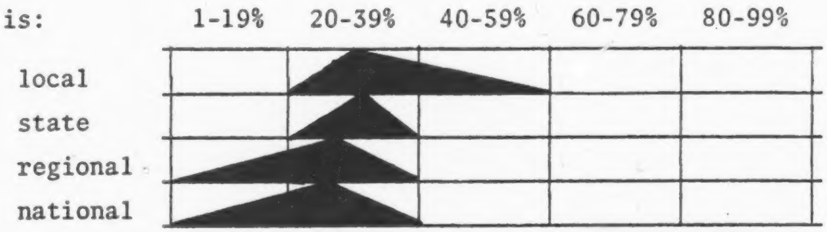
25. Education should be available to all who want it 24 hours per day, 365 days per year. 1 2 3 4 5 [✓ 6] 7

26. Standardized programming should be used in poorer school districts while affluent school districts should take advantage of the variety and diversity of programming which they can afford. 1 [✓ 2] 3 4 5 6 7

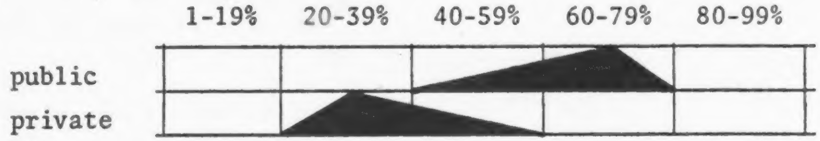
27. Technology should be used to study ways to improve theories of behavioral conditioning so that students will learn the correct responses with greater ease and speed. 1 2 3 4 [✓ 5] 6 7

FIGURE 3: ORGANIZATIONAL STRUCTURES IN LARGE-SCALE DELIVERY SYSTEMS*

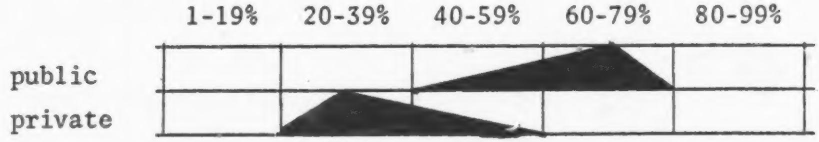
Organization - percent of the co-ordination and operation of the delivery system is:



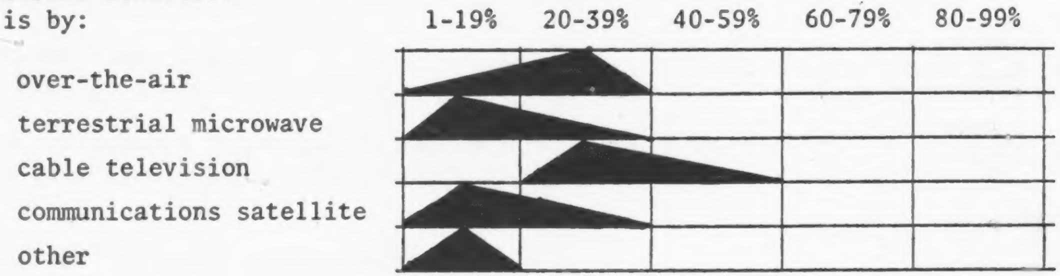
Control - percent of the control of the delivery system is:



Finances - percent of the funding or financial support of the delivery systems is from sources which are:

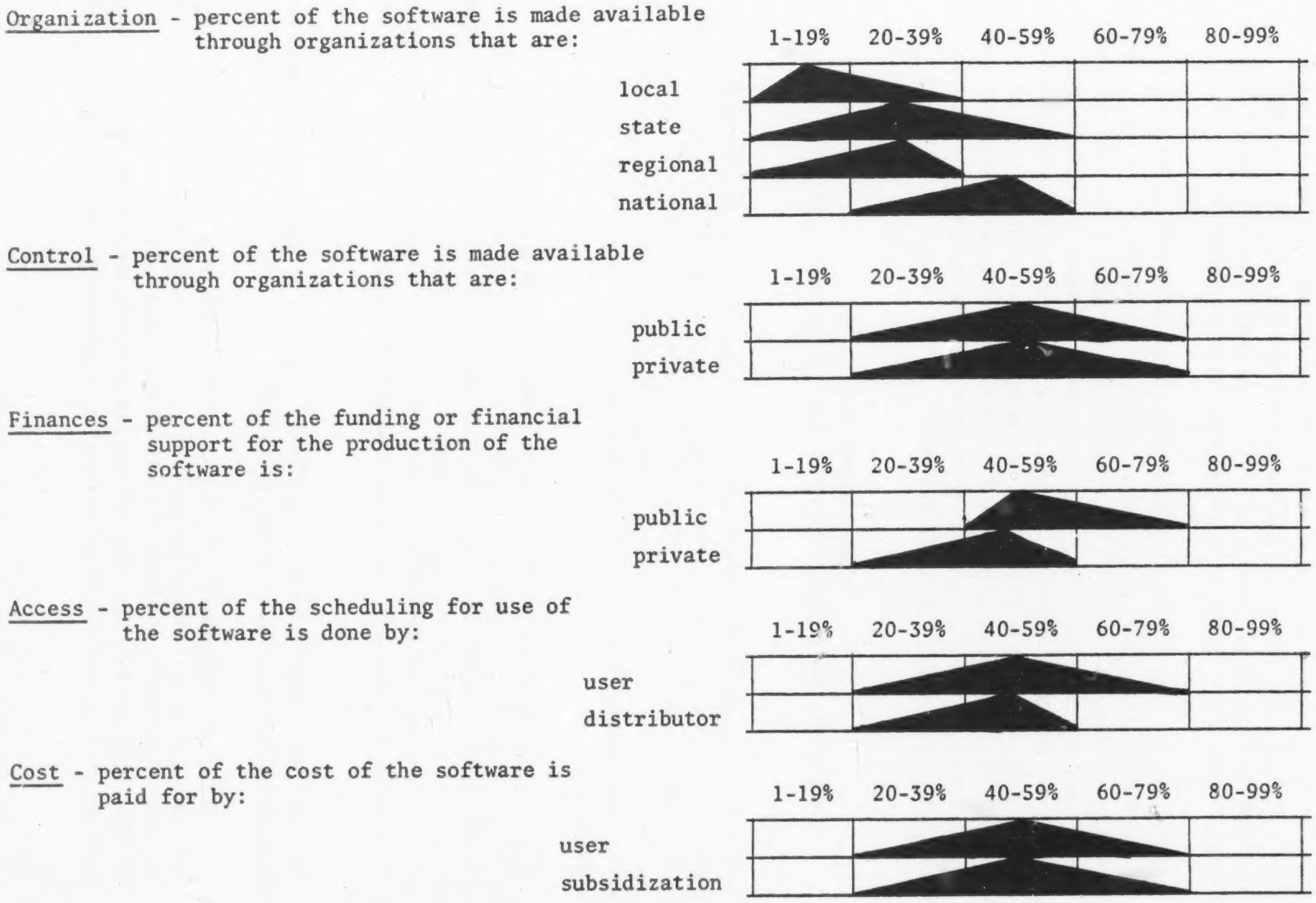


Distribution - percent of the material delivered over the systems is by:



*The triangle represents the middle 50 percent of the responses for the year 1990, the peak being the median response.

FIGURE 4: ORGANIZATIONAL STRUCTURES IN LARGE-SCALE SOFTWARE SUPPLY SYSTEMS*



Organization - percent of the software is made available through organizations that are:

Control - percent of the software is made available through organizations that are:

Finances - percent of the funding or financial support for the production of the software is:

Access - percent of the scheduling for use of the software is done by:

Cost - percent of the cost of the software is paid for by:

*The triangle represents the middle 50 percent of the responses for the year 1990, the peak being the median response.

be expected to be favored over private inputs. Private influences on finances and control are stronger in software than hardware. Coordination and operation of delivery systems seem to be oriented towards local control whereas software supply tends to be made available through state and national organizations. About half of the software requires subsidization.

Based upon the responses from his Delphi study, Robinson (1973) built a scenario for 1990 which is similar in many respects to one written by Parker (n.d.) about communications technology in education in 1985. Both scenarios see the following: television as the most significant technology; teachers as important components of education; hardware and delivery systems being available but not used for educational purposes until adequate software is available; utilization of educational technology beginning with other non-formal or non-traditional education. Robinson's (1973) work includes a detailed scenario as well as a summary of panelist's comments concerning equal opportunity and individualized instruction, technology and dehumanization, societal change, economic issues, political issues and utilization levels.

CONCLUDING REMARKS: PRODUCTIVITY, SCHOOL SYSTEMS AND EDUCATIONAL TECHNOLOGY

An issue of concern to planners and policymakers is that of how do you get the public schools to become more productive. The National Academy of Engineering (1973), recently addressed this issue in a report of its "Workshop on Application of Technology to Improve Productivity in the Service Sector of the National Economy." A major study on the subject of "Productivity and Efficiency in Education" has also been undertaken by a panel of the Federal Council on Science and Technology.

Anderson and Greenberg (1972), in a study entitled "Educational production Functions for Teacher Technology Mixes: Problems and Possibilities," have examined prior research relating educational inputs to educational outputs through use of educational production functions. This topic is very pertinent to considerations of productivity in school systems. Although changing the inputs to education by introducing technology may hold forth promise of increasing productivity, it is the relation between the inputs and outputs, and ultimately the output itself which is of key importance.

The Anderson-Greenberg study concludes with some insights which point the way towards future undertakings related to school system productivity:

> "Our original expectation was that we would be able to find enough studies using the same media to teach a subject that we would be able to derive some estimates of the 'best' combination of teacher and media to produce a given output. This expectation turned out to be naive. Although there have been several hundred studies of media use, few are reported in sufficient detail to be useful, nearly all have merely substituted a television performance for a

> live lecture and then made comparisons on a standard test which, for all we know, could have been based on a textbook. There were not many studies which systematically varied the mix of teacher and media and sought differences in output which could be associated with each type of combination. These are the sorts of studies which must be undertaken to produce data which has much practical utility.
>
> There are, of course, educational outputs which cannot presently be quantified, some of which may never be satisfactorily measured. But many educational objectives, particularly at the elementary and secondary levels, can be and are measured. The difficulty of defining outputs should not be taken as an excuse to do nothing; at a low enough level of aggregation -- such as reading or addition -- reasonable people can agree on what constitutes acceptable levels of performance. However, educators and parents will have to agree on the desirable outputs, and methods to teach these skills with as few undesirable side effects as possible will need to be investigated. This done, we may find that adverse side effects are more often the result of frustration from not learning anything, than the result of a technique which successfully teaches reading, arithmetic, or some other subject (pp. 41-42)."

Anderson and Greenberg's remarks highlight two areas for future research directed towards improving school system productivity through educational technology, namely: 1) documentation and evaluation of cases from a cost-effective or production function point of view in which teacher-technology mixes have been or are being utilized and 2) experimentation with new combinations of teachers and technology in which inputs are carefully selected and outputs carefully evaluated. Without such information, it will be difficult to convince school boards and school administrators to adopt more technological approaches to education.

A key factor in fostering technology-based alternative systems is long-term, adequate federal support for experiments and demonstrations. There is a need to provide support for innovative individuals whose efforts can make a difference on terms which do not stifle creativity and imagination. Sesame Street and the Electric Company are two examples of such innovative efforts.

Acceptance of technology by teachers might be improved if technology were to become a concern of university-level teacher training institutions. Until teachers themselves become interested in using technology, its introduction in school systems will be difficult. The lack of interest in participating in the Robinson Delphi study on the part of teachers would indicate that there is a long way to go. Furthermore, increased unionization and legal restrictions concerning teacher-pupil ratios and accreditation present formidable barriers to technology utilization. Therefore, it may be best initially to try to demonstrate productivity increases outside of the formal, traditional school system.

Some factors which are acting to bring about more widespread use of technology in the public schools have been analyzed by Lipman (1973). They include: 1) the driving force supplied by the development of technologies and the systems analysis techniques by agencies such as the DOD, NASA and AEC, and their interest in obtaining "spinoffs" for their efforts in the civilian sector; 2) the predicament of school districts which are being called upon to be pedagogically and fiscally "accountable" and which are flirting with the vision of using technology to obtain more cost-efficient education; 3) the ascendance of a behaviorist learning theory which is supportive of the systematic use of technology to improve education. Lipman states that the convergence of these developments constitutes a powerful force working towards large-scale use of educational technology.

The concern for productivity seems understandable in view of the factors outlined above. And it may be that technology will live up to its visionary promise. However, educating human beings is a much different process than mass-producing cars or growing tomatoes. The very concept of productivity itself, though appealing to technologists and taxpayers may, if implemented thoughtlessly, turn-off those people most intimately involved in the educational process, namely the teachers and students.

Therefore, caution is in order. Experiments with teacher-technology mixes should be viewed as just that; namely experiments. Impacts upon children, teachers and society as well as test scores should be carefully and impartially evaluated. Productivity related cost-effectiveness and cost-benefit studies and demonstrations require thoughtful consideration of the words after the hyphens. Technology can help free minds or it can help enslave them. Minds are what education is all about.

FOOTNOTES

1. A somewhat similar distinction between two definitions of instructional technology can be found in the Report of the Commission on Instructional Technology (1970) which called for future government participation on a much larger scale than before in educational technology endeavors.

2. NIT = National Instructional Television.
   GPNITL = Great Plains National Instructional Television Library.

3. For a discussion of these concepts as applied to education, see Grayson (1972).

4. CPB = Corporation for Public Broadcasting.
   PBS = Public Broadcasting Service
   NPR = National Public Radio.

5. Like the new Agency for Instructional TV formed by NIT and the Council of Chief State School Officers.

6. The difference between "fixed" and "broadcast" satellites emerges from the following definitions of service categories. The broadcasting-satellite service is a space communication service in which signals transmitted or retransmitted by satellites are intended for direct reception by the general public. The fixed-satellite service is a space communication service between earth stations at specified points. Two distrinct categories exist in the broadcasting satellite service: systems that allow for individual reception by simple receiving units in homes, and systems which are designed for community reception.

7. It should be recognized that these views of the NEA may not necessarily be shared by or of immediate concern to teachers.

8. One commercial operator did originally offer in a proposal to the FCC five TV channels to educators for five years free of charge with an unspecified rate to be set after the five years. At this point in time, it is doubtful if this capacity could have been utilized even if the unspecified rate were also free.

9. Analyses and planning for future educational telecommunications systems using satellites is being carried out at the Center for Development Technology, Washington University. For more details, see Morgan and Singh (1973) and Morgan, Singh, Anderson and Greenberg (1973).

10. Detailed reviews of computer technology and utilization in education have been prepared by Singh and Morgan (1971b, 1971c).

11. Neither Plato IV nor TICCIT cost estimates include software costs. Software costs per student-hour would depend upon the user population and could be very small for very large user populations.

12. This latter category includes library information resource sharing, time-shared computer networking, and management information systems, among others.

13. Robinson's results bear some similarity to those of a previous forecast of educational technology carried out by Doyle and Goodwill (1971) of Bell-Canada.

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DISCUSSANTS' REMARKS

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JOSEPH L. DI STEFANO'S REMARKS

This paper (Dr. Morgan's) of all those that I have read seems to hit home the most. The authors address the real problems as I see them, but do not fail to add that touch of humanity necessary in our expanding age of technology. We all generally agree with a statement such as: "An integrated system of teaching and learning for which the cost is reasonable and for which software has been specifically developed, tested in practice, revised, retested, and finally validated is most necessary." In fact, that was our discussion last night. However, who supports this costly process and how do we get a profit-conscious private sector to implement that concept?

In the discussion on video-reproduction, once again we face the old software dilemma: who produces the software? How soon could they possibly begin to provide meaningful programs in a quantity sufficient to meet individual needs and, I might add, quality? To quote the authors again: "In general, no cost estimates are attempted, although it is stated that costs of producing effective educational programs in money, skills, testing and revision and time have been consistently underestimated." Amen.

We consistently say that education cannot be treated like a business. I contend it must, when spending dollars, be cost-conscious and know what it takes to produce programming both for the present and the projected future. This is one way we can become more businesslike.

If we agree that ITV is an important mode of instruction, then we need federal support to produce quality programming, to change teacher attitude, and to convert school administrators from thinking that ITV is an add-on cost and that they should start thinking about a total instructional program.

I further believe that private business has to take an interest in our problem, and we need to join with the private sector to begin mapping out the future, being ever mindful not to kill the goose that may lay the golden egg.

The entire area of CATV is the most exciting and, in my opinion, has the greatest educational potential of all the technologies we are presently dealing with -- if for no other reason than that it can reach into every home with a TV receiver. However, we have a tremendous job of educating to do. How do we do it?

On April 23rd of this year our state legislature lifted a moratorium on cable franchises. The Public Utilities Commission, in its rules and regulations, made only one brief reference to education, and all it did was cite what the FCC has. Our department decided to go out to each Superintendent of Schools in the state and inform him of his obligation to speak up for education when the negotiations for franchises were being negotiated at the local level. I was appalled by the lack of knowledge on the part of school administrators. It was very obvious to me that they are not ready for anything of this magnitude. In fact, many of them feel that they are so far away from the utilization, why even bother with it. They are not taking into consideration the fact that these franchises may be let for 15, 20, 25 or even 30 years, as many of them have been.

They are not prepared to deal with the problem of CATV. More importantly, they have no philosophy regarding ITV in their districts. They are not even ready to put receivers in in some instances. And I am citing specific examples. This is realism.

I point this out only to say that these are the decision-makers and they are not ready. How do we reach anyone below the decision-maker to affect any change; namely, how do I reach the classroom teacher?

New Jersey is comprised of 602 school districts, of which the majority have a student population of 2,500 students or less. The method of financing education is a critical problem; we have alluded to this before in discussing the tremendous number of budget defeats. The question I have to ask myself realistically, at the state level is, how do we expect technological change under these conditions?

If I can get in a commercial: The Bureau of Instructional Technology is required to disseminate information, implement in-service training, and make people aware of the kinds of things we have been talking about. What do I have for a budget? $75,000 -- $57,000 of which goes towards salary for three people and two secretaries. The commitment made initially by the state legislature was to be implemented by a person I consider to be a great man -- Carl Marburger, but he is no longer there. So what is the future in a state that has had at least the ability to recognize that there should be an agency within the department for instructional or educational technology? In fact, to my knowledge it is the only state in the country that has done so.

We did not take the audio-visual office and convert it to an educational technology group. The audio-visual office still exists as a separate entity unto itself. The recognition is there, but the support is not there; and I contend that if change is going to take place it has to start from the top and we have to identify the people down below. And, I might add, that this makes it very frustrating. All the things we have said here for the past three days are tremendous for me and I have learned a great deal, but I have become even more frustrated because I know I have to go back and I can not do anything.

In Dr. Shane's general proposal, he points out some very interesting things. I find, however, that what he is advocating was as important to children in the early 1900's as it is today -- things like physical exams, age three beginning of school, individualizing, enhancing self-image, the history of the future, work service programs, community education, etc.

Anyone who has ever been in a classroom realizes the importance of the above. The interesting thing about the above is that money has necessarily inhibited them from being employed. The arguments for change are solid -- teaching through individual differences, continuous operation of the school, extending it to all ages. And the seven policies mentioned, I think are very appropriate. We have to do something about these arbitrary segments -- K-5-3-3- or the K-8-4, etc., promotions, the failure policies, the grade levels, the fixed grouping, the report cards, the grading, the diplomas and the certificates.

While I think these things are archaic in many respects, how do we get the general public to accept the above stated changes? You have to change the attitude on the part of the parent. When I was a child, I took home a report card, and I expect my child to take home a report card. I went to a specific grade and I expect my child to go to a specific grade.

The minute we start to change too radically, it is interesting to note that the most educated people send their children to private schools because they believe that the public sector is not really providing for their children, In many instances, the greatest amount of technology is being used in the public sector and not in the private school.

How many would it take to implement those things? And the big question is: Will it be too little, too late?

The changes contemplated are most interesting and provoke some questions. For example, the abandonment of fixed-admission-age policies is fine. What would this do to enrollment and what would it do to state aid plans? I agree that laws can be changed, but it can take a long, long time.

When speaking of an extended school year, how do school systems finance such a venture? I know that in our state we have, at present, two pilot projects on extended school year. We have one person in charge, at the state level of implementing the extended school year concept, and he has a meager budget to work with.

The curtailment of compulsory education would require a look at state aid plans again, and the entire concept of financing education.

When discussing the area of paracurricular experiences, it would appear that start-up money for schools would be considerable in view of the fact that they are not geared for such work now. I can not help but keep coming back to cost. I know everybody says that is all I am talking about, and that is all I think about, but that is the realism of trying to implement these things. I do not know how many of you have been in the position of trying to implement without having money. It is very frustrating.

W. THACHER LONGSTRETH'S REMARKS

I disagree with Dr. Shane when he claims that teachers will accept his proposals. I do not know what teachers you have been talking to, but I disagree with that. On the contrary, administrators were once teachers, they have fears, and they are not too subject to change.

The big question is: How do we reach the decision-maker -- the man on the street, the grass roots person, the everyday consumer who pays the freight?

Value crisis, indeed -- how do you teach values with a Watergate staring you in the face, a Vice President being investigated? This is a classroom teacher's dilemma. How do you restore pride in one's work, in one's self, in one's country? And most importantly, what about human compassion and understanding when we are talking about all these things?

I agree we must consider the swarm and what the future will be, but how can we implement change? I hope futurists come up with a design, a plan that we can begin to implement.

By coincidence, I had, over a period of time, developed a sort of catch-all talk that was designed to answer the constant inquiries of program chairmen when they asked me what I wanted to talk about: "Can't you talk about something that relates to the future? What's the Delaware Valley going to be? What do you see ahead in the next 30 or 40 years?"

I reached the same conclusion that you gentlemen did about ten years ago when I put the basic talk together and entitled it "Magalopolis 1984." It seemed to me that that was about the time when things would reach the kind of crescendo that would necessitate some specific actions, and we really did not have until the end of the century to start to make some of the decisions that we discussed.

I have been a science fiction buff all my life -- stuff by people like John Windham and John Christopher, who wrote about the evolution of huge, present-day social problems into a period of the future where they would all reach fruition, more or less simultaneously, to create the kind of disasters that are often foreseen by futurists.

What I tried to do really, both in reading the two papers and in listening to these discussions this morning, was to note some of those aspects that would certainly relate to the eventual role that education will play in the world that we will face in 15, 20 years from now -- or maybe ten.

We talked about population control, and certainly there is no question that virtually every social problem that you look at today relates to over-population -- not necessarily nationally, but certainly in local areas. Population has to be looked at today, I think, not just in terms of total numbers, but in terms of concentrations particularly.

Population control, as I see it, ultimately means that every child that is born in the world is wanted. Our ability to accomplish that fact and then to go on to a very natural redistribution of population is a matter of record. In 30 years we have doubled our population from about 100 to 200 million. During this same period, two-thirds of our counties have lost population.

That is an incredible fact, but 2,000 out of the 3,000 counties actually lost population at a time when we added 100 million people. The impact of that on virtually every aspect of our society is, of course, incalculable.

I think that in examining the process of redistributing the population and looking at the impact of crowdedness upon our future, I would like to bring out two points. One is the factor, again statistical, that if you had all of us living under conditions of crowdedness similar to those, for example, that are endured by people in Harlem or on the East Side or West Side of Chicago or in North Philadelphia, you could concentrate all the population of the United States in Long Island; and I think the results would be just about the same.

I think there is really no chance of solving the social problems that bring this curve to a crescendo ten or 15 years from now unless we demonstrate first of all, the ability to maintain a level of population which is governable worldwide, that we have an equitable plan to redistribute that population. I think an awful lot of what is done in the future -- and this will determine where many of the schools will be and where your technology is going to be applied -- will depend on how successful we are in achieving this redistribution.

Let me give you some idea of how significant I think it will be. I attended a meeting last night and was talking to a man who lives in Reston, Virginia -- a planned city pretty well put together by Gulf Oil. He told me that the residents are looking for an "out" now, and the reason is that they have to have a city of a certain definite size in order to "make it work as a part of the plan." But they can not put any more sewers into that particular area and so, for something as mundane as sewers, Reston apparently has reached the limit of its growth long before anyone could possibly imagine.

This is happening, apparently, in the whole of Fairfax County. I was astonished to find out that one of the really important growth areas of the world is now being brought to a halt by something as incredibly innocuous as sewers.

Superimpose on that the problem of what we are going to do to meet the energy crisis of the future. I think our ability to solve this problem will probably have as much to do with where the world is, and particularly where the United States is in ten years, as any of these other matters that we have discussed.

I look at the impact of integration and our lack of it to date, and what effect it will have upon where the educational system is going to go. I think that that is at least as important, if not more so, than the degree to which we are able to apply technology.

I look at land-use planning. As I travel around the country I am astonished by the fact that what was originally regarded only a year or so ago as some sort of idiotic thing that a few educators were talking about is now becoming commonplace, for example, the idea of limited growth. All of a sudden, governors and mayors and senators are talking about limiting the growth in their states.

I spent a week or so in Oregon recently, and all they want you to do in Oregon is go home. They are not even interested in having you as a tourist. Their idea is "we want to keep Oregon the way it is and we are not going to do it if we get the kind of population explosion that California has had thrust upon it over the last 15 or 20 years."

The aspect of no-growth, and the great discussion between quantity and quality, is something that we have to reagrd in terms of any future planning.

Something that will have a profound effect on the redistribution of population is our mass transportation system. Our ability to get lots of people back and forth, in and out of the cities; our ability to learn to re-use the cities, rediscover them, rebuild and reestablish some of their values, will have a profound effect upon education.

I think eventually you are going to find that young people, before their children are born, and old people, after their children are born, will be almost totally concentrated in the cities. We see in the high-rise apartments that are being built here that kind of redistribution of population. It is happening more or less accidentally now. People with kids naturally gravitate towards the suburbs at the present time because the suburban schools are felt to be better. How much longer they will be, I think, is a question. But because of that factor you are automatically segregating people into living patterns which I think have a profound effect upon how the educational institutions are run.

In regard to private schools, I think that ten years from now it is very possible, maybe even probable, that some form of voucher system or some form of competitive system will have been constructed, which may very well result in the ruination of the public school system as we presently see it. I think that the whole methodology and the way in which so many people are turning to private schools today, for one reason or another, is something that is going to have a strong, determining effect on our future.

Adult education, brought on by leisure time in a longer life span, is something on which I think we have only scratched the surface. I think if education does not meet the adult challenge, corporations will do it themselves. They are already well along the way at the present time.

Finally, I think one thing we can be certain of is a very, very substantial change in our government. I think the most frustrating experience I had while serving in the Philadelphia City Council was the fact that we could not get anything done. Anything we tried to do that would change the status quo immediately brought out large groups of irate citizens and, more important, large groups of greedy and relatively capable lawyers who were able to hold up almost anything that they wanted to, more or less, indefinitely.

I do not care whether you are trying to build a new school, new highway, new industrial plant, new residential area or a high-rise apartment, whatever it might be, there are always large numbers of people opposed to it. While they are not quite able to stop it, they can delay it long enough so that it stops itself.

I think we have reached the point now, where the needs of large groups of people, opposed to the ability of small groups of people to hold up those needs are such that when superimposed on the issue of crime that exists today and people's tremendous uptightness about that issue, there will be a turn towards a form of autocracy in our government that, to my way of thinking, dooms democracy in its present form -- the form we see it in now.

I think the point brought out by both speakers, that people in one voice say they want democracy and yet negate that by almost everything they do, is a pretty good indicator that we are going to have to have a much more autocratic system of government -- one which enters much more into our lives, on a continuing basis, in order to get the things done that are going to have to be done in order to avoid some of the catastrophic forecasts made in the papers just presented.

RECOMMENDATIONS

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The previous parts of this report dealt with the substance of the commissioned papers and the discussants' statements. Over 200,000 words were transcribed from the proceedings. How best to treat these and distill the most applicable statements presented a problem. To arrive at a reasonable solution, a methodology for treatment was developed to insure that everything said could be systematically classified. As indicated during the symposium, identifying who said what was never considered. More important was distilling what had actually transpired.

This section presents a justification for the selection of this methodology, explains how the methodology was used, analyzes the data by levels and variables, and presents specific recommendations.

Justification

Basically, three approaches were initially considered. The first was to do a clean-up job of the recommendations that came out of the symposium's last session. After a review of the tapes and transcripts, it became apparent that this approach would be totally inadequate because it would not be an accurate reflection of the many discussions which took place.

A second approach, that of content analysis, was considered and discarded because of cost, time, and reliability factors. Also, the task of training professionals to conduct a content analysis with the tools provided by Bernard Berelson would be a major undertaking in and of itself.

Classification was considered as a third methodology. This was finally accepted as a sound basis for reporting the proceedings because it most nearly met the needs of both RBS and NCET. This approach took into account the careful examination of issues, problems, strategies, and recommendations, as well as the key word descriptors which were part of the proceedings.

Methodology

An analysis of the original request for proposal and RBS' subsequent response produced key word descriptors. These were:

Economic costs for education

- instructional costs
- administrative costs
- operating facilities costs
- maintenance of facilities costs
- amortization costs
- depreciation costs
- health costs
- transportation costs

- Benefits
  - students
  - educators
  - taxpayers
- Implementing Technology
  - knowledge of previous problems
  - successes
  - new emerging technologies
  - trials
  - costs
- Issues
  - defined
  - clearly communicated
- Papers and Discussions
  - clarify problems
  - recommend solution strategies for:
    - a) management models
    - b) planning cost models
    - c) input-output factors
    - d) human factors
    - e) political factors
    - f) social factors
    - g) availability of technology
    - h) technology for educational productivity
    - i) recommended experiments and demonstrations to be conducted.

The above were further reduced to produce an analysis form (matrix) that would allow for the initial coding according to level and variable(s). Key words were used to indicate level: **issue, problem, strategy,** and **recommendations.**

Variable levels included:

- management
- input-output
- human
- political
- social
- economic
- implementing
- productivity
- availability
- other

Two professionals were trained in coding. They read all the papers and transcript material and made single entries on a separate card for each entry by level and variable(s). They coded a total of 403 separate cards. These were entered on colored cards to determine their source and to enable further analysis. Blue represented commissioned papers; green the presentations; yellow the discussants; and pink the discussions.

The frequency of the first pass of coding and sorting is illustrated on the following page. It should be pointed out that the variable, "Other," included research and development, communication, documentation, and value concerns.

After the initial sorting from the classification coding, a second sorting was carried out by three professionals working independently. Their objective was to reduce areas of redundancy and duplication. This sorting decreased the total number of cards from a quantitative frequency of 403 to 328 classified statements (see Second Analysis Frequency).

A third sorting involved judging the quality of statements and avoiding any unnecessary overlapping. The results of the third coding and sorting can be seen on the Third Analysis Frequency. The number of coded statements was further reduced to 276.

Finally, a fourth sorting merged the quality of ideas into a reportable form. The results of this stage are reported in the next section.

ANALYSIS BY LEVELS AND VARIABLES

Reducing over 200,000 words into a usable document was a sizable task. While the following report may contain errors of judgment, an effort was made to reflect the participants' contributions accurately.

FIRST ANALYSIS FREQUENCY

	Level			
Variable	Issue	Problem	Strategy	Recomm.
Management	16	3	16	0
Input - Output	6	0	0	0
Human	38	12	8	0
Political	23	1	11	1
Social	4	0	0	0
Economic	48	8	21	2
Implementing	69	17	28	8
Productivity	23	7	9	1
Availability	9	2	2	3
Other	17	3	5	4

Totals	**233**	**51**	**100**	**19**

Grand Total = 403

SECOND ANALYSIS FREQUENCY

/	Level			
Variable	Issue	Problem	Strategy	Recomm.
Management	15	2	12	0
Input - Output	5	1	5	0
Human	33	10	8	0
Political	21	0	9	1
Social	2	0	0	0
Economic	33	8	19	2
Implementing	48	15	27	7
Productivity	17	0	0	1
Availability	6	2	1	3
Other	7	1	3	4
Totals	**187**	**39**	**84**	**18**

Grand Total = 328

THIRD ANALYSIS FREQUENCY

	Level			
Variable	Issue	Problem	Strategy	Recomm.
Management	11	2	13	0
Input - Output	7	1	3	1
Human	20	8	8	0
Political	19	0	9	2
Social	2	0	0	0
Economic	30	9	20	0
Implementing	34	21	22	2
Productivity	10	0	0	0
Availability	3	2	1	1
Other	6	1	5	3

Total	**142**	**44**	**81**	**9**

Grand Total = 276

A further grouping of the variables clearly indicated that some of these fell into similar classifications. For instance, before one can implement or manage anything, the question of availability must be resolved. Also, key variables, which were called "cousins," seemed to form a collection of classification variables. These were identified as follows:

- Group I
  - human
  - social
  - political
  - other (value, R&D, documentation)
- Group II
  - economic
  - productivity
  - input-output

Some obvious gaps were noted thus making it difficult to cover each variable on a vertical and horizontal plane for purposes of analysis.

This section presents issues, problems, strategies, and recommendations.

Issues

Two major issues emerged at the outset of the symposium. These were: 1) the definition of "productivity" and 2) the availability of educational technology. The group generally accepted the following as a definition for productivity:

> **Productivity is defined as the amount of output or results obtained from a given amount of input.** To this definition **efficiency** was added **as the attainment of the maximum possible output with a given amount of inputs, or the attainment of a given output with the possible amount of inputs.** (Rogers and Jamison)

Availability of educational technology was covered in some depth in four case study presentations of fairly complete instructional systems that represented some "significant" uses of the "hardware" available. Since each of these studies is presented as a part of the report, no further amplification is necessary.

Availability -- is an issue in that little has been done to document available technology for potential consumers and users. Much has been developed but the question of how to best use these advances remains unresolved.

Programming, i.e. instructional content for computers, the lack of initiative on the part of publishers, and the need for an adequate delivery system presented some selected issues. In reality they are problems.

Sesame Street and the Electric Company television programs are clear examples of what can be done when a broad delivery system is available.

Value(s) -- while not appearing as a major issue, the question of values did underlie some concern on the part of many participants. This was further delineated in dealing with the conflict of "now" versus the "future" and was best expressed as "...we have to be very, very careful that our own value systems and our own biases are not imposed on what we are projecting for this generation; and, God knows, if we are planning for the next generation, we have to be very well aware of further changes in the value system."

Of course, this begs the question of how and who will determine present and future values. Human, social, and political values cannot be ignored.

Research and Development -- received little attention as issues except to point out the need to develop mechanisms for applying technology to the total educational process, particularly in such areas as system hardware and software, communications techniques, course development, instructional psychology, educational management, information systems, and total learning systems.

Documentation -- was a critical issue and came up many times in the discussions. It was repeatedly pointed out that the number of supposedly well documented technological innovations were limited in data, especially in the public school area. Obviously, if educators and the community at large are not sufficiently informed, little or no communication can take place. The result will be a slow down in decision making and adoption.

Human -- issues are probably at the base of any changes which can be anticipated. These will cut across problems and strategies and also be paramount in dealing with political considerations.

An examination of these issues was surprising in that there was a genuine concern for humans as opposed to a protective or defense mechanism in operation.

A listing of the major human issues are:

- teacher performance ratings and salaries depend on student learning
- teachers, students, and others must feel comfortable in using educational technology
- there must be total involvement to gain acceptance
- we need to measure the impact on change as it affects students, teachers, and society

- the effect of technology on the status of humans must be understood

- technology will need to be considered as a means for retraining all segments of education

- technology can ease the burdens of teachers.

Cutting across human concerns was the need to generate total involvement and communication. Perhaps one of the best ways to state this is that experiments with teacher-technology mixes should be viewed as just that, experiments. Impacts upon children, teachers, and society as well as test scores should be carefully and impartially evaluated. Productivity-related cost-effectiveness and cost-benefit studies as well as demonstrations require thoughtful consideration of the words after the hyphens. Technology can help free minds, or it can help enslave them. And minds are what education is all about.

Social -- issues covered almost nothing except to point out that education does have at least two goals other than education; one is that of employment -- the other is a babysitting kind of function. It may well be that before innovations are easily adopted, these other two functions will need to be resolved.

Political -- issues represent another concern. It is here where the sacred cow will be encountered. The real challenge will be to avoid becoming a "Luddite" while moving toward an advocacy position for change. Participants drew hard lines and generated a great deal of heat around political issues.

Selected comments to illustrate the point are:

- Must break the total lockstep of education itself...a captive team of education from K to 12 has been institutionalized to the degree that we are afraid to touch it.

- Ignoring union contractual arrangements in class size is to ring the death knell for innovation.

- Preparing the general public to demand through their politicians the greater aspect of technology is going to make you fight with the union.

- The federal government should not spend any money for technology but rather work for vouchers and free choice.

- Key issues yet to be fully resolved include: decentralized versus centralized control; long-term versus short-term financing; independence versus political interference.

- Accountability discussions can be expected to produce a wide-range of opinions about specific objectives...educational experiences may not have any specifiable or measurable objectives which can be designated prior to the learning experience.

- From the vantage point of parents and other community members, the adoption of an innovation may mean that local educators have relinquished their control.

- The future role of the federal government in developmental and operational programs needs to be defined.

- The private business world has to take an interest in our problems.

No segment of the political arena involving humans escaped comment. From student to legislator -- all are involved and have a stake.

The next grouping of issues deals with productivity, economics, and input-output. While it is recognized that all of these have some commonality, here each is dealt with separately.

Productivity -- tended to flounder on an ill-defined sea and did not really get much response from the group. Indeed, a number of these issues could just as easily be a part of economics. The chief candidates in this variable follow:

- Let the customer be responsible for either driving the cost down or stabilizing it.

- We need cost/learning, not cost/teaching.

- Productivity must be geared to the labor intensity of cost. Drive the labor cost down.

- To be effective we must teach at least as well as we currently do.

- Differentiating staff and restructuring roles must take their place along side shared responsibility for instruction.

- The very concept of productivity itself, though appealing to technologists and taxpayers, may, if implemented thoughtlessly, turn off those very people most intimately involved in the educational process, namely teachers and students.

Capital intensity and labor intensity seem to be the reverse side of the productivity issue. Reverse because it is a comparatively new language for educators who have not had to concern themselves with optimal conditions. The real trick will be to spell out optimization as a goal.

Economics -- was far easier to comprehend since this usually deals with dollars. Somehow, most people understand dollars and their effect upon them. A problem was where do the dollars come from if innovation in educational technology is to occur? Some of the issues raised included:

- increased productivity can result from salary increases

- an outside funding source must act as a catalyst

- decentralization versus centralization must be resolved
- long-term versus short-term financing is a real issue
- the most cost effective use of computer assisted instruction will be compensatory education
- the cost of predicting effective educational programs is consistently underestimated because cost accounting is not kept for the varying levels of development
- labor intensity must be decreased through restructuring roles
- state aid distribution needs to be re-examined
- a dearth of data exists on cost effectiveness
- more effective evaluation methods are needed to get at productivity and cost- effective questions.

One general observation that could be drawn was that the majority of participants felt the squeeze of dollar constraints. Symptoms are usually the first tell-tale signs of larger problems.

This is illustrated by the statement that the regulations involving how school districts receive and allocate funds force them to make artificial distinctions between modes of instruction. An economist would say that the financial structure of the schools biases the mode of production; it tends to force schools to pivot instruction around the person physically present in the classroom and tends to make educational technology a peripheral and marginal part of the process.

Yet, instructional television may be the most cost-effective approach available. The issues are real, but solutions can be found.

Input-Output -- processes seemed to be the least understood area. This appeared to be partly because of the terminology. At times, one had the feeling that an attempt to measure the unmeasurable was in operation or that, far worse, there was a wisdom lag.

The recognition that better input data were needed certainly existed. This was reflected by the comments for all kinds of indices in all areas including cognitive, affective, and the whole range that dealt with the satisfaction of those dealing with the total educational enterprise.

Suggested outputs dealt with achievement, impact on children, teachers, society, learning facilitation, and cost/learning.

The concept of **process** as representing the middle of input-output went almost unnoticed. For example, Individually Prescribed Instruction is a process used as a part of input-output. Measuring

IPI would require a thorough analysis of the middle piece, process, if one is to derive output. This issue received further treatment under the section of recommendations dealing with documentation. After all, if documentation does not exist, input-output is irrelevant.

A majority of the participants recognized the need to develop more efficient ways to handle input-output. One example, while humorous, provided the essence of the matter, The John Henry Effect. In any experiment that you run, say a class taught by technologically-based instruction versus traditional instruction, you may have a Hawthorne effect with students in the experimental group, but you also have a John Henry effect with the teachers in the control group. In other words, they'll be damned if they'll let that steam drill beat them down. They work harder than they did before. This is the process!

Implementation -- was not directly traceable to the previous variables. Certain factors can be noted, but these do not have any necessary relationship. However, some overlapping is noticeable. A listing of implementation issues rather than comments is presented:

- There is need for pre-service and in-service training
- There is a need to serve as a catalyst to sell and market in an ethical and competent manner
- Administration is not enthusiastic about educational technology
- Monitoring is important
- Forget model building, interrupt linear progression and collapse time
- Examine a variety of alternatives
- Involve teachers early in the process of decision making
- Prepare user oriented reports
- Depend on nationwide resource of talent
- Allocate dollars to teachers for tools
- Stop trying to innovate teacher and student proof materials
- Need resolution on the kinds of information and support for educators.

One sound piece of advice was rather than organize and be efficient and effective and charge ahead, a better course might be to look at value questions and some of the alternatives and then choose one and work toward that. In the long run, this may be more efficient and effective than following the work ethic of "let's go."

Management – was saved for the last issue. First, one needs to know what to manage. No thread could be found that wove through the management variables. Rather, some general ground rules were stated as issues. Basically, the management issues were as follows:

- Maintain the integrity of the planning and development stages through the implementation stage
- Institutionalize the products of curricular and instructional design
- Demonstrate evidence of an understanding and a readiness for the kind of hard-nosed involvement by the central staff in the design and execution of the system
- Re-define the school year
- Share instructional responsibility and avoid territorial imperatives
- Data are conflicting and confusing in making choices and decisions
- We must begin to hold students accountable for learning outcomes
- More stress has to be placed on designing comprehensive control systems
- New staffing patterns must be found (invented)
- More non-systematizing of the student and greater choices need to be made available.

While the above is not prolific, it goes a long way to providing for better management which could in turn open the door of acceptance for broader based experimentation.

Commonalities -- can be noted among the many issues. A risk in reducing data are losses. Chief among the common threads were:

- Capital intensity needs to be reduced
- New staffing patterns and uses must be found
- Better documentation and communication needs to take place
- Labor intensity needs to be reduced
- Our systems must involve more people in policy and decision making.

Problems

While one could be accused of stretching the point between definitions of issues and problems, it did serve a useful end. Fewer problems were raised than issues, but this was to be expected. Why? Because when a group is together for a short period, and working together for the first time, issues will surface much faster than problems. It is far more comforting to raise an issue than to suggest dealing with a problem.

An effort was made to further reduce any redundancies that might exist between issues and problems. The variables were greatly reduced and include availability, documentation, human, economics, implementation, and management.

Availability -- was seen as a real problem because technology and the system for delivery was never designed to meet the needs of educators. Further amplication was cited as follows:

- There is an inadequate system for software production and distribution
- There is a lack of effort to convince people that CAI is cost effective
- There is an absence in adequate theories of instruction on which to base CAI systems
- The traditional roles of teachers have not changed to take advantage of CAI
- There is a lack of technological research and development.

Documentation -- was covered by one summarized statement: We still do not have the scientific facts that we should have from documented sources so that we know where we have been.

Human -- problems were somewhat different in that there was a recognition of resistance. These were stated as follows:

- How do you get the teacher to become patient and believe in a program and grow into a program which you describe as being an involving one?
- Why is teacher resistance to television as direct instruction causing a decline in use even where the medium has been effective?
- Why is there confusion concerning definitions and objectives?
- Why is there a lack of conclusive research and evaluation?
- Why do teachers make commitments at the planning level and fail to carry out the operational or technical level?

- Why have we not learned to use contemporary equipment creatively in improving educational experiences?

- What kind of human interaction is necessary at any given point?

- What do we need in a human situation that can maximize learning?

- What types of persons do we need?

All of the above questions are human and quite penetrating. Answers are few.

Economics -- when viewed as problems, really focused on money. Key questions were:

- Why is it difficult to get information on productivity, cost-benefit, cost-effectiveness?

- Why is there a lack of analysis on various kinds of experiments and demonstrations using technology in education?

- Why do projects funded by foundations and federal money disappear upon termination of funding?

- Why do costs keep going up and productivity down?

- Equipment choices involve costs. Why are administrators concerned about these costs?

- Why do schools fail to think through the fiscal ramifications of an experimental project if it is successful?

- Where do we get the money to get from where we are today to where we could be in the future?

- Why has the sharp curtailment of federal money in the last few years revealed the extent to which local funds are out of balance with real costs?

Implementation -- problems tended to get at the very foundation of our institutions. The major questions that could be framed from the symposium were:

- What do we need to appreciate the extent to which the pattern of institutions, laws, organizations, traditions, and habits that form the superstructure of education operate to inhibit educational technology?

- How do we avoid having the present superstructure prevent alternative modes of instruction from competing as options for the student?

- How do we get past the institutional constraints in order to introduce further technical applications?

- How do we further reduce the utilization of labor?

- How do we implement technological innovations which involve more than print material?

- How do we achieve a natural language capability to make coding and editing easier?

As can be seen, most of the questions involve institutional or people constraints. This is not unique since most innovations are done in institutions by humans.

Management -- had only one problem that did not appear under issues. It was -- What assistance do developers and users need to determine what changes, if any, will result in staffing patterns and job responsibilities when educational technology is used?

Again, it seems necessary to point out that it is difficult to specify management problems in the absence of a specific management responsibility for a specific innovation.

Strategies

The strategies that emerged from the symposium were general in nature and while helpful, they did not trace any one educational technology from inception to replication. These have been culled to avoid unnecessary duplication.

Availability -- called for increasing the development rate of technological aids for learning skills, use of vouchers or other means to bring about the learning cognitive skills outside school, and substituting achievement tests for course requirements.

This seems to be a means that lacks an end. If the intent, which is not clear, is to extend schooling beyond formal attendance, then an end can be seen. Vouchers in and of themselves need further definition.

Documentation -- was suggested as a means to bypass legal constraints for experimentation. To do this, it would be necessary to keep baseline data on all critical undertakings so they can be referred to as needed.

Human -- interactions, similar to a soft sell, were offered as a means to accelerate the adoption of educational technology. These are broken down as follows:

- Leadership initiative

- Teacher participation and support

- Constructive interactions among business, government, and educational representatives

- Involvement of teacher training institutions

- Use of interface forms that students but not teachers use

- Avoid challenging the authority of teachers in their own territory.

A further strategy suggested that, to achieve success in utilizing instructional technology, general needs be recognized and agreed upon, a well articulated purpose to guide the project be created, a structure be designed for success, leadership be at the right level of authority, teacher participation and support be acquired, a mechanism for measurement and evaluation be developed, adequate resources be provided, and responsibility and control be exercised. Prescriptive? Perhaps, but there is a ring of logic to the preceeding factors.

Political -- strategies were clouded to some degree by power-oriented suggestions. Some factors crossed into the economic arena but still kept their political nature. Suggestions included:

- Before a school district is awarded a cost-effectiveness demonstration grant, a detailed plan must be presented showing: 1) how the products of the planning stage will be institutionalized; 2) how the continuing operation of the project can be carried on with normal resources of revenue; and 3) how the project will or will not be affected by state and local regulations and agencies when outside funds are phased out.

- Locate states for demonstrations with a known history of flexible state laws and a history of few labor problems.

- A thorough investigation of state laws should be conducted.

- Put pressure where it belongs to get greater amounts of money allocated to education to be utilized in producing technology-based facilities for all new structures being constructed.

- Use the threat or mandate of performance based competency for future teachers with a part of the requirement being an understanding of technological environments.

- Suggest projects where teachers are substituted for other capital intensive inputs.

- Spell out the price of labor in sufficient detail to make the case obvious to any reader.

Economics -- were brain-stormed. Instead of an analysis, a listing is provided.

- Insure adequate resources

- Allocate district funds on the basis of student achievement

- Provide federal support for validation of educational technology

- Provide federal support for validated products
- Provide a teacher allowance for acquiring new tools
- Provide long-term federal support
- Provide tax write-off advantages for a variety of groups
- Create a competitive marketplace.

Underlying the above is the assumption that our institutions need incentives to change or that new competitive means have to be created. The means to the end were sharply debated but no common point emerged.

Input-Output -- suggestions had three basic notions:

1) Make the evaluation of students a public process

2) Provide federal support for external validation

3) Create a task force to generate criteria for the assessment and evaluation of educational technology innovations.

The above tend to demonstrate a basic need for refining, documenting, and developing strategies. An absence of process can be noted.

Implementation and Management -- points have all been covered before and are not repeated here except to note that they were picked up in the original frequency sorts.

Recommendations

Recommendations were sorted based upon each participant's response to the subject.

An abbreviated form of these recommendations are:

1) An interagency panel be formed to formalize cooperation among inter, intra, and external agencies.

2) Studies be commissioned to determine the state-of-the-art and to support, coordinate, and synthesize research findings.

3) Develop the characteristics and limitations of media information relative to educational technology problems.

4) Develop guidelines and standards for use by industry in promoting the development of educational technology.

5) Create an agency with the sole mission of covering all aspects of educational technology.

6) Make investments in the design of experiments to formulate and test instructional theories which could facilitate the development of educational technology.

7) Commission some major demonstrations on productivity outside the formal school system.

8) Develop specifications for major mass demonstrations in educational technology.

While the above recommendations have not been grouped around any of the variables, they do fall into the three major categories of research, documentation, and demonstrations.

The final section of this report deals with these in greater detail.

RECOMMENDATIONS

Usually the greatest heat is generated about the means to an end rather than with the end itself. While few would question the broad goal of improving the productivity of our schools by using educational technology, many would quarrel with the how or means of doing it. People tend to resist that which they do not understand. Educators are no exception.

Educational technology is best defined as the application of scientific processes and products to the improvement of education. At its worst it is considered labor saving hardware and electronic gadgetry. We would all do well to remember that it is up to the makers of machines to carry out the tasks we present; it is not up to us to warp our systems in order to provide work for machines designed to do something else.

This section will deal with general observations and present specific recommendations regarding research, standard documentation and demonstrations. Development, as a process, will be used as an integral part of the recommendations.

General Observations

Upon the conclusion of any three day symposium most participants would agree that they have far more questions than answers. The RBS symposium was no exception.

A few general observations are offered as a way of establishing a background from which specific recommendations can be made. These observations are not intended to be complete or discrete. Rather, they are intended to capture some of the thoughts that transpired.

Participants -- The background of the participants was varied and covered a breadth of education. Constraints, as identified, were not limited to a horizontal base, but were also vertical in nature. For example, what effected the representative of a state department also had an impact on the local administrator and the classroom teacher.

While some of the participants had pioneered in developing new technologies for educational programs, others were seeking ways to implement these within existing educational settings. No panaceas were offered.

Most of the participants demonstrated a willingness to have effective change but could not see a comprehensive way to get at it. This led to some either/or remarks:

- We must move to vouchers
- We need more documentation
- It must be done outside the system
- Technology must be validated
- Teachers must change

Seldom was the question **"why"** asked. All of this is symptomatic of a much larger problem -- the lack of priorities, systematic planning, testing and analysis.

Issues -- When looking at issues and problems it was apparent that a hard documentation was unavailable to the majority of participants. It did not matter if the discussion centered around economic costs, benefits, input-output, management, availability of technology, implementing technology, or human, social and political factors. Less than a total picture existed.

The reality of an issue for an administrator or a teacher, by definition, usually involved cost factors. Each saw this as operating on an already limited budget. Success or failure was secondary. Common statements were:

- We need to communicate
- We need a variety of indices
- We need more basic research
- Documentation is lacking

An analysis of the issues clearly showed gaps which suggested inadequate planning and organization of knowledge. Differing audiences have differing informational needs. If the teacher, administrator, state department representative, or funder (whether local, state, or federal) lacks complete information, policy and decisions cannot be made. The flow and types of information are critical.

Organizing Knowledge -- Anybody who has had to organize knowledge in any systematic way comprehends the difficulty of the task. We know much more about educational technology than has been documented.

When telephones first hit the market they were considered a luxury. Few people had them. As business and humans discovered the need for telephones, the instruments were widely adopted and became a way of life. Now telephones are considered a necessity and seldom is the cost considered.

Another example is the typewriter. Scribes did the work of a typewriter for many years. As a typewriter became a support tool for the conducting of business, it moved from luxury to necessity. No business would be without these machines. On any day, in any business, typewriters are idle for long periods of time. No cost benefit questions are raised on this issue.

The same thinking can be applied to computers. In 1965 about $50 million was spent in higher education on computers. Today the figure is $540 million plus. Cost benefit was not considered critical when looking at this expenditure. If it had been, computers would still be quite limited in use.

An inescapable fact emerges. Computers are going to be a part of humans for as long as humans exist. How we adapt and to what uses we can put computers becomes highly critical for public education. The cost may exceed the normal budget of local schools initially because start-up costs are usually high. Can our schools ignore the fact that their products -- learners -- will be users of computers?

The previous examples were not used to denigrate the participants, or cost benefit as a measure. Rather, the examples (albeit simplistic) were used to demonstrate the need for the multiplicity of measuring instruments to collect and organize knowledge about the new technologies.

It is a reasonable expectation to see cost reductions, for things (objects) which can be mass produced. One striking example of the computer follows:

"In the year 1954 it cost $1,000 approximately and took more than a month to perform a million operations. As the years went by the cost dropped and the time for doing these operations got shorter. The predictions [sic] are that by 1975 or 1985 it will cost something like a tenth of a cent and it will take a tenth of a second to do a million operations; and they predict from 1983 to 1997 the cost will drop by another factor of a hundred." (Morgan)

To what end can public education utilize this finding? Dealing with mere fragments of information has not served a good end. Unless knowledge is organized and carefully documented for a variety of users, educational technology will languish -- far worse, the very goals of education will be distorted.

One hallmark of science is to provide enough verifiable description about the experiment and data. Other researchers can then draw the same general conclusions about the results. This approach to measurement is missing in educational technology and there is a paucity of data as it deals with cost effectiveness.

Optimization -- Questions related to the increase of productivity through technology in education are going to be difficult to maximize until certain fundamental issues are explored. It seems reasonable to optimize productivity as we gain more documentable knowledge. However, the goals of education are not optimal. If they were the questions related to productivity and capital would not be paramount.

Too often society settles for less than the optimum. True satisfaction is not reached and the outcomes are frustration and apathy. School budgets which have to be adopted each year tend to guarantee short range planning for education. Stop gap measures become the order of the day. The best schools can hope for is that some of what they teach students will help them in the future as they are confronted with new problems. This leads to the development of narrow specifications, designed to work today. Initially the cost seems reasonable, but the results ten or 15 years from now could be disastrous.

Resolution must be reached between the immediate and the future. One could question whether time is on our side to wait for alternative futures to be developed prior to taking action. On the other hand we do not have the luxury of conducting business as usual. This could pose a value conflict that must be faced.

Many forces impinge on the development of policy for education. Not the least of these are self-interest, political, social and human factors. Achieving an intelligent, rational approach for the optimization of education will not be easy.

The Medium and the Message -- Without casting aspersions, it seemed that the symposium was heavy on technological medium and low on technological message. The delivery mediums were quickly articulated including computers, television, audio-video tape response systems, and combinations of satellite, cable television and computers.

For example a grouping of the recommended programs included:

- Behavioral Research Laboratories experiment in the Banneker School in Gary, Indiana
- Audio Tutorial
- Year round education, 45-15 plan

- Individually Guided Education
- Early reading (SWRL Laboratory)
- Sesame Street and the Electric Company
- The Duluth Plan of Individualization
- Class Response System
- Drill and Practice including experiments in New York City and Chicago
- Golden Key Laboratory
- Comprehensive Achievement Monitor (CAMI)

With few exceptions, messages, or programs were limited in number.

When the messages, programs to be used with the mediums, were examined the state-of-the-art would have to be rated at a much lower level. Few sophisticated systems utilizing many processes of technology were visible. What this tends to suggest is a need for a more careful search for a variety of educational programs and imaginative processes to deliver the message. If the investment in program has been low it should be considered as an area for investigation. After all, as Berne said, What can you say after you say HELLO?

New Approaches -- The conventional approaches of research, development, dissemination, diffusion, and evaluation have not accelerated the pace of utilizing educational technology to increase the productivity of schools. Too often the above is perceived as a linear model with neat progressive steps to be followed.

Without going into a discourse on the tomes of scholarly literature that describe how to do it, it seems sufficient to say that new approaches should be explored. Individuals have more personal knowledge than has been collectively documented. Many of the individuals developing new technologies are too busy with day to day events to record the data.

RESEARCH, DOCUMENTATION AND DEMONSTRATIONS

The recommendations that follow are based on the logic of having to move forward in a planned way to improve the productivity of our schools through the wise use of educational technology.

Admittedly certain limitations preclude a less than perfect state for research and development. We simply do not have all the answers. This should be recognized, but not used to deter new approaches.

At the heart of the recommendations is an open admission that new approaches must be developed. Educational technology should be treated as a problem of engineering. Research under these conditions would represent efforts designed to provide answers for demonstration problems. The recommendations are grouped under three headings: research, documentation and demonstrations.

Research

The four recommendations offered for research are:

1) **Basic Research** -- must be expanded in learning theory, teaching theory, biochemical studies, and the sociology and anthropology of education.

2) **Limited Research** -- must be continued with projects that meet specified criteria in selected areas of educational technology. Enough money and time must be allocated to insure success or failure. Three year funding or less is not going to yield answers.

3) **Problem Oriented Research** -- must be conducted on specific needs that come from demonstrations. It should not be the role of the demonstrator to solve research problems. However, it is a suitable role for the demonstrator to identify specific problem areas that need research answers.

4) **Evaluation of On-Going Research** -- needs to be done across all federal levels of government. It is critical that the National Center for Educational Technology knows what the National Science Foundation, the National Institute of Education, and other departments are funding in educational technology. A great deal of know-how exists at the federal level and it needs to be shared both internally and externally. This would let potential consumers know what is happening and what they may be able to adopt in their educational programs.

Documentation

One broad recommendation is offered under documentation. The federal government needs to conduct a seminar on standard documentation. A highly select group of individuals with multi-disciplines should participate, and the agenda should be limited to the development of documentation guidelines. Unless standards are adopted nobody is going to know where anything is at any given time. Also, in the absence of hard documentation policy, decision makers will be adopting on less than a scientific approach.

The following areas are not intended to be more than suggestive of the kinds of things that need documentation. It is totally reasonable for contractors to request specific information of their projects.

A. Historical documentation

1. social sources
2. primary sources
3. external criticism
4. internal criticism
5. quantitative analysis of documentary materials

B. Financial Accounting

A careful examination should be made using the National Center for Educational Statistics **Financial Accounting, Classifications and Standard Terminology for Local and State School Systems, 1973.** This handbook covers a lexicon of terminology including indirect and direct costs. While objects and functions are separated some of these would be most useful as a part of documentation. Operating programs and support programs can be clearly delineated. For example, support systems include:

-- Pupil-Staff Support

-- Administration

-- School Administration

-- Planning

-- Research

-- Development

-- Evaluation

-- General Services

-- Operation and Maintenance

-- Transportation

- Staff Services
- Processing Services
- Indirect Costs (table 6)
- Total Indirect Cost
- Direct Cost Operating Programs

-- Total Cost of Operating Programs Formulas are provided and should result in more accurate cost documentation of projects.

C. Case Records

- Psycho-Physical
- Health
- Educational
- Mentality
- Health History
- School History
- Family History and Home Conditions
- Social History and Contacts

D. Descriptive Documentation

- Analysis
- Classification

E. The Pre-Development Cycle

The cycles that follow were synthesized by RBS from NASA, General Electric, and the Department of Defense as a process to track projects from pre through field development. This cycle is concerned with surveying the needs of school systems and establishing constraints and criteria which will be utilized in making decisions about targeted developmental efforts and the resources to allocate to each. Generally, this also involves the development, assessment, and comparison of alternating approaches to satisfying these needs. Trade-off studies are conducted to weight the relative merits of each approach in terms of total costs, effectiveness, schedule for implementation and constraints or limitations placed on them. The output of this cycle is a set of specifications and plans sufficiently well documented to provide baseline information for a management decision about the extent to which respective design alternatives should be funded. Broad operational definitions are provided for the stages.

1. Need(s) and Objective(s) Identification

This stage is concerned with determining and documenting the socio-economic needs and plans of a local, regional, state or national level which affect the planning of an educational program. It includes defining an educational program in terms of broad approaches which will provide for the identification of needs, identify the target group(s) and determine the resource requirements and the costs to implement such a program. An integral part of this stage is establishing the importance of each objective.

2. Constraint(s) Identification

In this stage it is important to identify those factors which will constrain or limit the approach(es) to meeting the identified objective(s). Constraints result from a variety of factors. These may be broadly seen as human, financial, timing, policy, and physical environment. Since it is not always possible to quantify constraints with a high degree of confidence, it is nonetheless desirable to specify the likely range of numbers to help understand their effects.

3. Translation

Translation involves the interpretation and detailing of objectives in the light of recognized constraints. It includes setting up measurable performance indices based on the objectives. This will generally require the further interpretation of socio-economic needs, target group(s), program requirements, and projections regarding resource unit costs and technological developments.

4. Planning Analysis

This stage is concerned with the identification of the system elements necessary to meet the identified needs, the determination of the relationships between the elements, and the development of possible approaches to attaining the objectives. The selected approaches should relate to the detailed objectives derived during the translation stage. This stage should also include for each of the approaches resource requirements, operating and capital costs, funding approaches, development tasks, schedules and decision points.

5. Selection Criteria

This stage involves the specifying of criteria which will be used in the next stage (trade-off) to select one or more of the candidate approaches for further consideration. Each alternative approach is viewed from the point of view of its expected contribution to the objective(s), to the probability that it can accomplish what it seeks to do and what each will cost.

6. Trade-Off Synthesis

In this stage the selection criteria are applied in choosing the approach(es) or tasks to be implemented. The results may, however, indicate the investigation of new approaches, in which case the cycle is re-entered at a previous stage (translation or analysis) and continued until alternatives are chosen. The next step in this cycle, synthesis, usually involves integrating the selected approaches or tasks into a development program.

The output of this cycle includes Development Requirements (design approaches and schedules) and Development Plans (tasks, schedules, decision points, funding and approach).

F. The Prototype Development Cycle

The aim of this cycle is to determine whether a particular concept of product/ capability should be continued to full-scale implementation in its intended environment. The meeting of pre-determined criteria influence the decisions to continue the development process.

Operational definitions for each stage are provided.

1. Analysis

Analysis is concerned basically with collecting knowledge and understanding about a system, product, or capability by breaking it up into its parts to facilitate the investigation.

2. Conceptualization

This stage is concerned with the synthesis or building up of the parts to create a conceptual framework upon which detailed design will be based. The output is a set of requirements for design.

3. **Design**

This stage is concerned with working out in detail the conceptualized system, product or capability. The output of the design is a set of specifications for the end product or capability.

4. **Construction**

Construction is concerned with moving from plans and specifications to building an operating system and testing of various components and planning for the implementation of a prototype product or capability.

5. **Implementation**

This stage is concerned with installing the developed prototype in a natural setting and running it for a sufficient period until acceptable levels of performances have been attained. It also involves 1) correcting, revising, or debugging the developed end product, and 2) adapting and converting old organization procedures and demonstrating new procedures which support the desired outcome.

6. **Evaluation**

This step is undertaken to determine the relationship between planned and actual accomplishments -- whether these be technical, administrative or behavioral. Its purpose is also aimed at testing the validity and effectiveness of the entire effort.

G. The Field Development Cycle

The focus of this cycle is to develop the necessary support requirements and systems to insure the intended use of the product or capability. The ultimate outcome, of course, is to produce products and capabilities that will have a major impact on education and be adopted on a wide-scale.

Operational definitions for each of the states follow:

1. **Field Operations**

Field operations are concerned with the replication, dissemination, demonstration, and monitoring -- engineering aspects during field tests.

2. **Production**

The production stage provides quality control, mass reproduction of the prototype, and the initial delivery through the field development cycle.

3. **Training**

The training stage provides the field development cycle with all the necessary training support involved in replicating and insuring the integrity of the product or capability.

4. **Appraisal**

The appraisal stage measures and establishes the necessary quantitative and qualitative value of the product or capability to insure consumer usability.

5. **Delivery Capability**

This stage occurs near the end of the development process prior to wide-scale adoption. Usually it will involve a developer and a commercial-industrial representative to plan for the logistics, support services, and possible packaging of the product or capability.

Interrelationship of Development Cycles

Each of the development cycles is closely related to the others. Although each provides information to the others below it in successive order, the previous cycles and stages receive inputs through a feedback process. That is, while analysis provides input to the conceptual stage, the conceptual process may indicate the need for still more analysis. A similar relationship exists among each of the other stages. Thus, the development process is reiterative, i.e. involves recycling of the stages.

Demonstrations

Major demonstrations should be conducted in an engineering manner. The field setting is the real developmental laboratory. While some research needs to be maintained, at least two major developmental-demonstrations should be mounted in educational technology, with the design to include increasing productivity in education.

Based upon the discussions, it seemed apparent that some participants wanted to start with a new institution or setting, while others strongly favored working within the existing structure. How to accommodate both and not run the risk of political alienation presented a major problem. In an effort to resolve what appeared to be a conflict, and at the same time begin major demonstrations, two differing environments are being recommended for full-scale experimentation.

A brief description of these environments and possible strategies follows.

Environment A -- is based upon the utilization of a school district that would have the capability to respond to a proposal on increasing productivity in schools through the utilization of educational technology. Criteria have to be developed internally at the federal level and externally for those districts desiring to respond.

Some considerations are:

1. Existing technologies must be carefully documented.

2. These technologies must be shared with potential bidders.

3. Five-year contracts must be considered.

4. Two years should be allowed for a design phase prior to any implementation.

5. Criteria for evaluating the school districts should be developed.

   Some of these criteria are:

   -- size of district

   -- past innovation record

   -- staff adequacy

   -- political know-how

   -- involvement of people at all levels

   -- cost accounting procedures that are at least reflecting the best of modern know-how

   -- ability to synthesize parts of technologies to make a large demonstration possible

   -- accessability for others

   -- goals of education clearly stated

   -- prior experience with some form(s) of educational technology.

6. Responses should be evaluated and documented

   -- needs and objectives

   -- constraint(s) identification

-- translation

-- planning analysis

-- selection criteria

-- trade-off synthesis.

7. Further evaluation should include questions relating to:

   -- management

   -- planning cost

   -- input-output considerations

   -- human factors

   -- political factors

   -- social factors

   -- productivity trade-offs

   -- strategies for implementation.

8. Weighted consideration should be given to the multiple configurations suggested by a school district.

Environment B -- is a deliberate design to cut across all institutions in order to hasten experimentation without running into all of the usual institutional problems. This would not preclude schools but would extend beyond schooling into education in a broader sense.

What is really being recommended is the letting of an RFP to construct a "Life Process Center for Education" which could be used by all levels of population from pre-schoolers to senior citizens. Such a center would include strategically placed satellites. Some of the processes could be:

- information requests
- career opportunities
- job employment
- legal aid

- social-welfare aid
- basic skill courses
- local government aid
- personal evaluation of self and situations
- library referencing.

Bidders for Environment B should be recognized for past ability to deliver in the area of educational technology. Other considerations should be made on the basis of certain existing mediums such as computers and cable television, and the outreach which exists in the environment.

Again, time for adequate design should be mandatory and a minimum of five years for large-scale demonstration be guaranteed.

CONCLUDING SUMMARY

We need not be discouraged about the progress that has been made to date in educational technology. However, a point has been reached which is going to require unique approaches to move into the questions of productivity in education. Establishing national policies and adopting some long-range plans will be one step in that direction.

A careful documentation of our progress and wise investments in research and developmental demonstrations can aid in accelerating growth. Finally, information designed to communicate with a variety of audiences should remove some of the mystique of technology and enhance the quality of life for all.

APPENDIX

SYMPOSIUM OVERVIEW

On August 20-22, 1973, the symposium on "Improving Productivity of School Systems through Educational Technology" was held at Sugarloaf, the Temple University Conference Center in Philadelphia, Pennsylvania. In attendance were 32 participants, ten who prepared commissioned papers, five discussants, four representatives of the Office of Education and one representative of the National Institute of Education. A complete symposium attendance list follows on pages 371-375.

During the three days of the symposium, the sessions were organized around the six basic objectives listed in the Introduction. During each session, the participant(s) who prepared a commissioned paper highlighted it in twenty minutes followed by two ten-minute reactions and open interactive discussion. A copy of the Session Schedule can be found on page 377.

The movie **Future Shock** was shown during the afternoon and evening breaks during the first day of the symposium.

To provide a complete record of the symposium, the proceedings were audio-taped and recorded by a court stenographer.

IMPROVING PRODUCTIVITY OF SCHOOL SYSTEMS THROUGH EDUCATIONAL TECHNOLOGY

Temple University Conference Center
Philadelphia, Pennsylvania
August 20-22, 1973

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REVISED

SESSION SCHEDULE

SUNDAY
August 19, 1973 — 6:30 - Cocktails and Buffet Dinner

	9:00 - 11:30 AM	1:00 - 3:30 PM	7:00 - 10:00 PM
MONDAY August 20, 1973	INTRODUCTION- JoAnn Weinberger CASE HISTORY - I - Sylvia Charp II - Suilin Ling Discussants State Department* Chamber of Commerce*	CASE HISTORY - Robert G. Scanlon Discussants Teacher* Administrator*	HUMAN, POLITICAL and SOCIAL FACTORS - Glenn Snelbecker Discussants American Federation of Teachers* Administrator*
TUESDAY August 21, 1973	ECONOMIC FACTORS - I - Roger Sisson II - Daniel Rogers Discussants Chamber of Commerce* Administrator*	MANAGEMENT FACTORS - Robert Heinich Discussants Teacher* State Department*	MEASUREMENT FACTORS - Marvin Alkin Discussants Teacher*
WEDNESDAY August 22, 1973	FUTURE - of TECHNOLOGY - Robert Morgan of SOCIETY - Harold Shane Discussants State Department* Chamber of Commerce*	RECOMMENDATIONS - James Becker	

*State Department
Joseph DiStefano

*Administrator
Orlando Furno

*Teacher
Eleanor Lonesome

*Chamber of Commerce
W. Thacher Longstreth

*Philadelphia Federation of Teachers - James Garberina

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The work upon which this publication is based was performed persuant to Contract OEC-0-73-6811 with the National Institute of Education, Department of Health, Education, and Welfare.